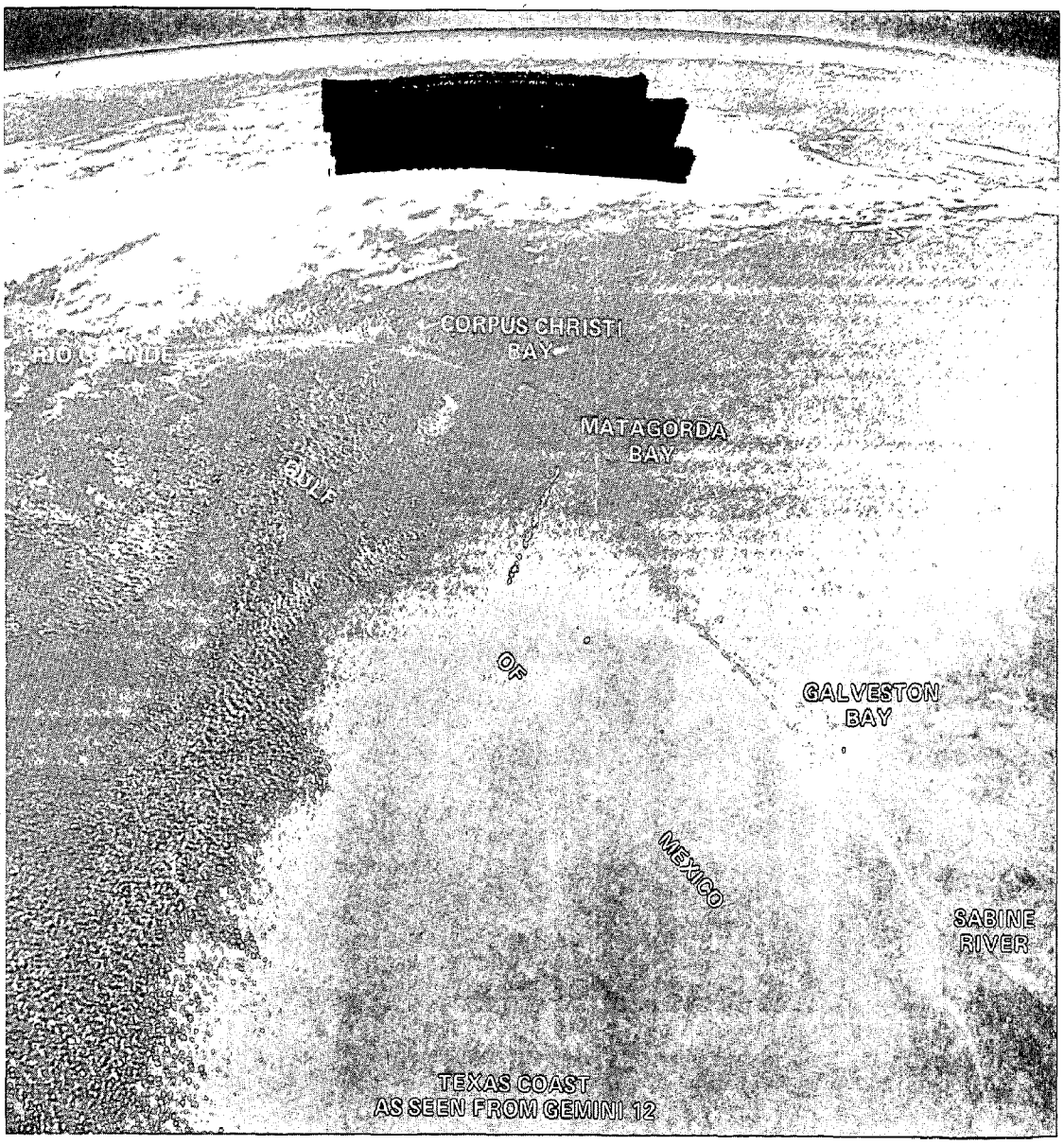
NATIONAL SHORELINE STUDY

TEXAS COAST SHORES

REGIONAL INVENTORY REPORT



U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS

GALVESTON, TEXAS

The National Shoreline Study

How will the shore be used ?

SEE

SHORE MANAGEMENT GUIDELINES

What is its condition ?

SEE

REGIONAL INVENTORY REPORTS

What can be done ?

to preserve or enhance the shore,
by using–

- Engineering techniques

SEE

SHORE PROTECTION GUIDELINES
REGIONAL INVENTORY REPORTS

- Management techniques

SEE

SHORE MANAGEMENT GUIDELINES

06538

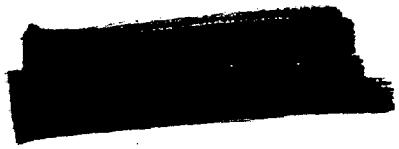
In 1968, the 90th Congress authorized this National appraisal of shore erosion and shore protection needs. This National Shoreline Study and the existing Federal shore protection programs recognize beach and shore erosion as problems for all levels of government and all citizens. To satisfy the purposes of the authorizing legislation, a family of 12 related reports has been published. All are available to concerned individuals and organizations in and out of government.

REGIONAL INVENTORY REPORTS (one for each of the 9 major drainage areas) assess the nature and extent of erosion; develop conceptual plans for needed shore protection; develop general order-of-magnitude estimates of cost for the selected shore protection; and identify shore owners.

SHORE PROTECTION GUIDELINES describe typical erosion control measures and present examples of shore protection facilities, and present criteria for planning shore protection programs.

SHORE MANAGEMENT GUIDELINES provide information to assist decision makers to develop and implement shore management programs.

REPORT ON THE NATIONAL SHORELINE STUDY, addressed to the Congress, summarizes the findings of the study and recommends priorities among serious problem areas for action to stop erosion.



NATIONAL SHORELINE STUDY
TEXAS COAST SHORES
REGIONAL INVENTORY REPORT

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EROSION OF THE TEXAS COAST SHORES
REGIONAL INVENTORY REPORT

INTRODUCTION

1. Authority. This report was prepared under authority of Section 106, Public Law 90-483, approved 13 August 1968, which reads:

> Sec. 106. (a) The Chief of Engineers, Department of the Army under the direction of the Secretary of the Army, shall make an appraisal, investigation and study, including a review of any previous relevant studies and reports, of the Atlantic, Gulf, and Pacific coasts of the United States, the coasts of Puerto Rico and the Virgin Islands, and the shorelines of the Great Lakes, including estuaries and bays thereof, for the purpose of (1) determining areas along such coasts and shorelines where significant erosion occurs; (2) identifying those areas where erosion presents a serious problem because of the rate of erosion, considered in conjunction with economic, industrial, recreational, agricultural, navigational, demographic, ecological, and other relevant factors, indicates that action to halt such erosion may be justified; (3) describing generally the most suitable type of remedial action for those areas that may have a serious erosion problem; (4) providing preliminary cost estimates for such remedial action; (5) recommending priorities among the serious problem areas for action to stop erosion; (6) providing State and local authorities with information and recommendations to assist the creation and implementation of State and local coast and shoreline erosion programs; (7) developing recommended guidelines for land use regulation in coastal areas taking into consideration all relevant factors; and (8) identifying coastal areas where title uncertainty exists. The Secretary of the Army shall submit to the Congress as soon as practicable, but not later than three years after the date of enactment of this Act, the results of such appraisal investigation and study, together with his recommendations. The views of concerned local, State, and Federal authorities and interests will be taken into account in making such appraisal investigation and study. (b) There are authorized to be appropriated such amounts, not to exceed $1,000,000, as may be necessary to carry out the provisions of this section.

This report responds to items (1) through (5) and item (8) of the authority quoted above, as related to the Texas coast. To comply with items (6) and (7), a report containing shore protection guidelines is being prepared by the Coastal Engineering Research Center and a set of shore management guidelines is being prepared by the Office of the Chief of Engineers.

2. Purpose. The purpose of this report is to present a general inventory of the nature and extent of shoreline erosion on the Gulf, bays and estuaries of the Texas coast, with possible remedial measures and approximate costs. The report describes shore use and ownership, and presents other information pertinent to an overall appraisal of erosion problems.

3. Scope. The limits of this regional inventory extend from the mouth of the Sabine River to the mouth of the Rio Grande, involving the 17 counties which extend along the Texas coast. The inventory is limited to the Gulf shores and the shores of bays and estuaries behind the barrier islands and peninsulas. For this report, only erosion caused by waves and currents generated by natural forces was considered. Shore and bank erosion along navigation channels caused by vessel traffic and changes in shoreline from land subsidence are not treated in the discussions of this report. Estuarine shores were inventoried only to the mouths of rivers or streams entering the estuary. For descriptive purposes, the coast has been divided into geographical reaches, designated Zones A through H, extending from the Louisiana boundary on the northeast to the Mexican border on the south. Index map, Plate 1, and detail maps, Plates 2 through 7, show the limits of each zone.

4. Coordination. During field investigations for this report, more than 200 persons were interviewed to obtain data pertinent to the study. Shore erosion problems and identification of specific areas were discussed with many interested Federal, state, county and city officials and private land owners. Interest in the study was found to be widespread and the excellent cooperation of the many persons and interests interviewed during the survey was very helpful in compiling this inventory.

DESCRIPTION OF COASTAL AREAS

5. Classification of shoreline. The Texas coast has been classified according to physical characteristics, historical shore changes, shore ownership and shore use. The total lengths of shorelines within these four categories and the amounts in each are shown in Table 1 for the Gulf shores and in Table 2 for the bay and estuary shores. This information is depicted graphically on Plates 2 through 7.

6. Physical characteristics. The shorelines of Texas may be divided into three general types according to physical characteristics. The types are (a) Gulf shore beaches, comprising mostly fine sand, shell and shell fragments, which slope gently upward from the water to the sand dunes with heights ranging from 5 to 40 feet; (b) coastal bay marshes of alluvial sand, clay and silt subject to frequent inundation by tides higher than normal; and (c) bluffs, ranging from a few feet to more than 40 feet in height, which are a result of erosion from waves generated by prevailing south to southeasterly winds. For the most part such bluffs are found on the north and west shores of bays.

7. Shore ownership. The Gulf, bay and estuary shores total 2,498 miles at the mean high tide line. Of this, approximately 82 percent is privately owned; 16 percent is owned by the Federal Government; and 2 percent is publicly owned by the state, counties, and cities.

8. Public and private rights. Although some clarifying legislation has been adopted by the State of Texas, considerable uncertainty still exists concerning the policies and principles relating to public and private rights to use and enjoy the beaches of Texas. This is best illustrated in a paper by Mr. Shannon H. Ratliff of the law firm of McGinnis, Lochridge, Kilgore, Byfield, Hunter and Wilson of Austin, Texas, which was included in "Law and the Coastal Margin," published by Texas A&M University National Science Foundation Sea Grant Program in April 1970. The paper discusses the many legal aspects of real estate development in the coastal margin and the problems which must be resolved to facilitate development. A portion of the paper is quoted below:

PUBLIC RIGHTS IN BEACHES

> It would seem under both the common law and the law of Spain that the area between mean low-water and mean high or mean higher high-water, as the case may be, is res communes and that the riparian owner may not exclude the public from this portion of the shores.

In 1959, the Texas legislature passed the Open Beach Law. This is an attempt to establish public rights in and to the area between mean low-water and mean high-water and also to establish an easement in the public area up to the vegetation line. However, if there is no clearly discernible vegetation line or if it begins more than 200 feet from the mean low-water line, then the easement only extends 200 feet from the mean low-water. This statute applies only to beaches on the Gulf side of an island or tract. Thus, along the Texas coast its application seems limited largely to barrier islands. However, two islands are excluded since they have no present access to the mainland.

The controversial parts of the statute from the developer's standpoint are extending the public's right to the vegetation line, and certain presumptions created in favor of the state. Under Section 2, once the Attorney General shows that the land in question is between mean low-water and the line of vegetation this constitutes prima facie evidence that the title of the littoral owner does not allow him to exclude the public from using the area for ingress or egress and that the public has a prescriptive right in the area for ingress or egress. This statute has never been construed by the courts. However, with continued beach development, cases are certain to arise in which the statute will be invoked.

A case in which the statute was discussed, but not construed, arose in Galveston. The statute did not come into play since the Attorney General avoided use of the statutory presumption. There, the court held that the public through long, continued use demonstrated by "proof" had acquired an easement by prescription in the beach.

The statute has been amended, perhaps to mollify owners, to allow the counties control of traffic and litter on the beaches. Under this statute some counties have closed portions of the beach to automobile traffic if other long stretches of beach are available for public use. The statute also seems to provide that nothing in the statute prevents an owner from refusing ingress and egress over his land to reach the "public zone" created by the statute. This requirement is satisfied by existing or future public ways to be provided by the counties. The statute seems to give more than it does in actual practice.

TABLE 1

CLASSIFICATION OF GULF SHORELINE EXPOSURE
(LENGTHS OF SHORELINE IN MILES)

	ZONES								
	A	B	C	D	E	F	G	H	TOTAL
A. PHYSICAL CHARACTERISTICS									
1. Shore that normally has a beach zone	24	65	11	41	27	36	35	122	361
2. Shore without a beach zone	11	0	1	0	0	0	0	0	12
B. HISTORICAL SHORE CHANGES									
1. Critical shore erosion	0	25	1	6	0	0	0	4	36
2. Non-critical shore erosion	23	1	3	16	8	5	6	3	65
3. Non-eroding (stable or accreting)	12	39	8	19	19	31	29	115	272
C. SHORE OWNERSHIP (AT MEAN HIGH TIDE)									
1. Federal	1	1	0	0	0	27	1	66	96
2. Public (Non-Federal)	0	7	0	0	0	0	1	4	12
3. Private	34	57	12	41	27	9	33	52	265
D. SHORE USE (1970)									
1. Recreational - Public	20	65	12	35	1	0	15	122	270
2. Recreational - Private	0	0	0	0	6	25	10	0	41
3. Non-recreational development	0	0	0	0	0	0	0	0	0
4. Undeveloped	15	0	0	6	20	11	10	0	62

TABLE 2

CLASSIFICATION OF BAY AND ESTUARY SHORELINE EXPOSURE
(LENGTHS OF SHORELINE IN MILES)

	ZONES								
	A	B	C	D	E	F	G	H	TOTAL
A. PHYSICAL CHARACTERISTICS									
1. Shore that normally has a beach zone	0	1	0	0	6	0	5	4	16
2. Shore without a beach zone	33	472	22	84	348	220	402	528	2109
B. HISTORICAL SHORE CHANGES									
1. Critical shore erosion	0	22	0	0	16	2	16	1	57
2. Non-critical shore erosion	1	58	0	0	50	12	29	44	194
3. Non-eroding (stable or accreting)	32	393	22	84	288	206	362	487	1874
C. SHORE OWNERSHIP (AT MEAN HIGH TIDE)									
1. Federal	10	35	0	8	0	93	40	106	292
2. Public (Non-Federal)	2	23	0	0	2	1	12	3	43
3. Private	21	415	22	76	352	126	355	423	1790
D. SHORE USE (1970)									
1. Recreational - Public	19	32	0	0	16	17	17	15	116
2. Recreational - Private	0	52	0	0	35	6	17	9	119
3. Non-recreational development	0	51	0	0	19	4	28	5	107
4. Non-recreational undeveloped	14	338	22	84	284	193	345	503	1783

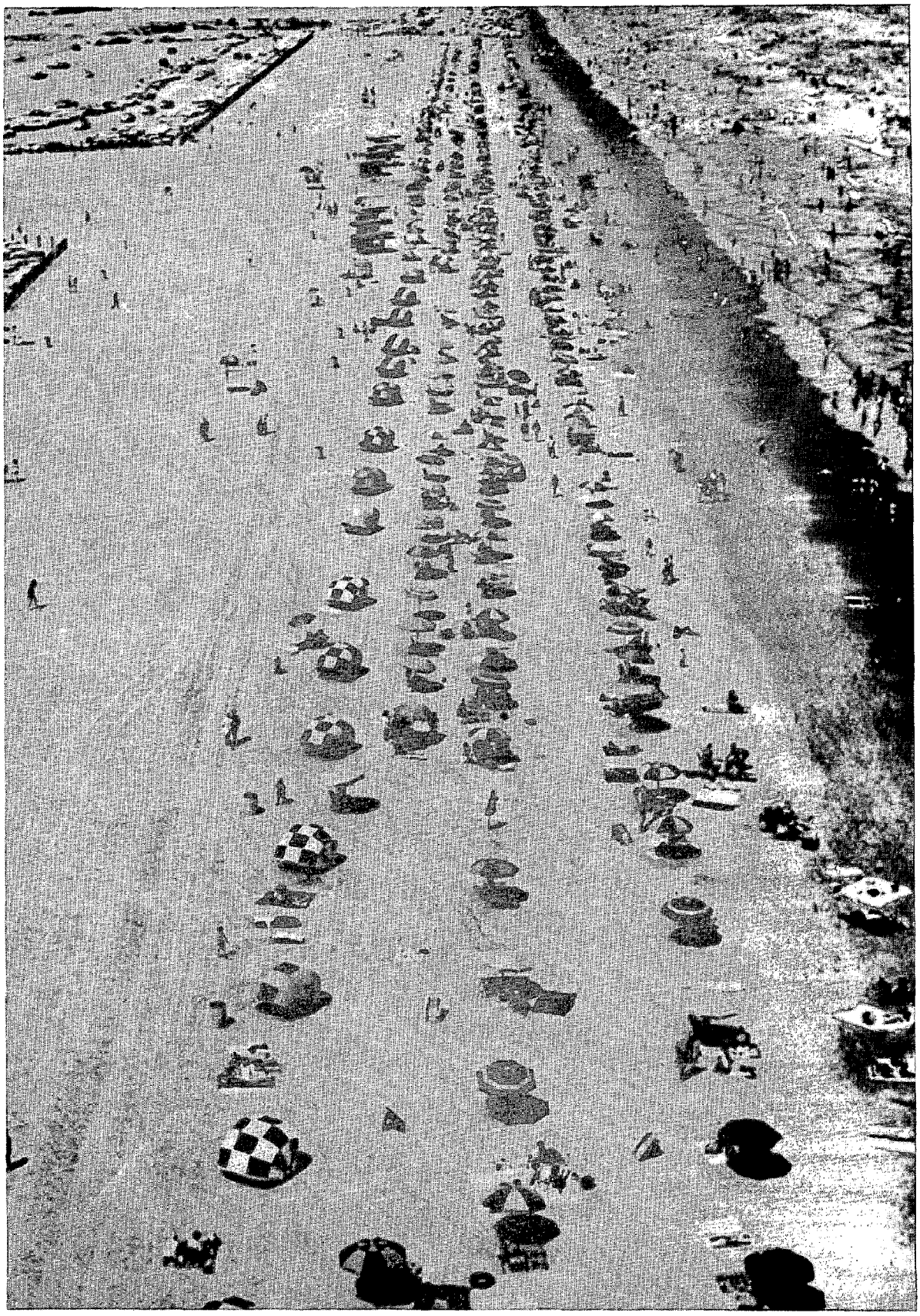
9. Existing development. A brief description of the shoreline of each zone of the Texas coast follows:

Zone A.- The shores of this most easterly zone are mostly undeveloped. Within the city limits of Port Arthur on the northwest shore of Sabine Lake, there are some recreational developments, principally for boating and boat racing. Two small towns are located near the Gulf south of Port Arthur. The westerly portion of the Gulf shore in Zone A is used extensively for public recreation, although virtually no facilities have been provided for public use or access.

Zone B.- This zone includes the largest concentrations of shoreline development along the Texas coast. The large Galveston Bay system, comprising Galveston Bay, East Bay, Trinity Bay, West Bay and several smaller bay arms, lies behind the barrier formations of Bolivar Peninsula, Galveston Island and Follets Island. A considerable part of Bolivar Peninsula is occupied by permanent and summer residences and numerous commercial establishments. The city of Galveston occupies about the easterly one-third of Galveston Island and the westerly two-thirds of the island has many permanent and summer-home type residential developments. A number of similar developments are located on Follets Island, west of San Luis Pass. The westerly shore of Galveston Bay is occupied by almost continuous urban type development from Texas City on the south to La Porte and Baytown on the north. Seabrook, Kemah, San Leon and a number of unincorporated communities front the bayshore in this reach. The city of Anahuac is located on the easterly shore of Trinity Bay near the mouth of the Trinity River. The Anahuac National Wildlife Refuge borders about 6.5 miles of the north shore of East Bay.

The East Bay shoreline of Bolivar Peninsula is extensively used for recreational boating and fishing. The north shore of East Bay is mostly unoccupied except for residential developments on Smith Point. The shores of Trinity Bay are mostly undeveloped excepting the Anahuac vicinity and the vicinity of Umbrella Point and Houston Point on the north shore, where numerous homes, boating and fishing camps, and some oil industry facilities are located. The upper end of Galveston Bay near Baytown is highly developed. Most of the shores are occupied by industrial, commercial and residential properties. The Galveston Bay shoreline from Morgan Point to Texas City, including the shore of Clear Lake and some of Dickinson Bay, is extensively developed with permanent and summer residences and some commercial establishments. The shoreline outside of the Texas City Hurricane Flood Protection System is, for the most part, undeveloped. A few recreation-oriented businesses are located in the unprotected area. The northerly shores of West, Bastrop and Christmas Bays are undeveloped except for a few summer home type subdivisions.

Galveston Island has about 32 miles of Gulf shoreline which is used heavily for recreation. A scene of typical heavy recreational use of Galveston's Stewart Beach during the summer months is shown in Photograph 1. About 10 miles of the Gulf shore of the city of Galveston is protected



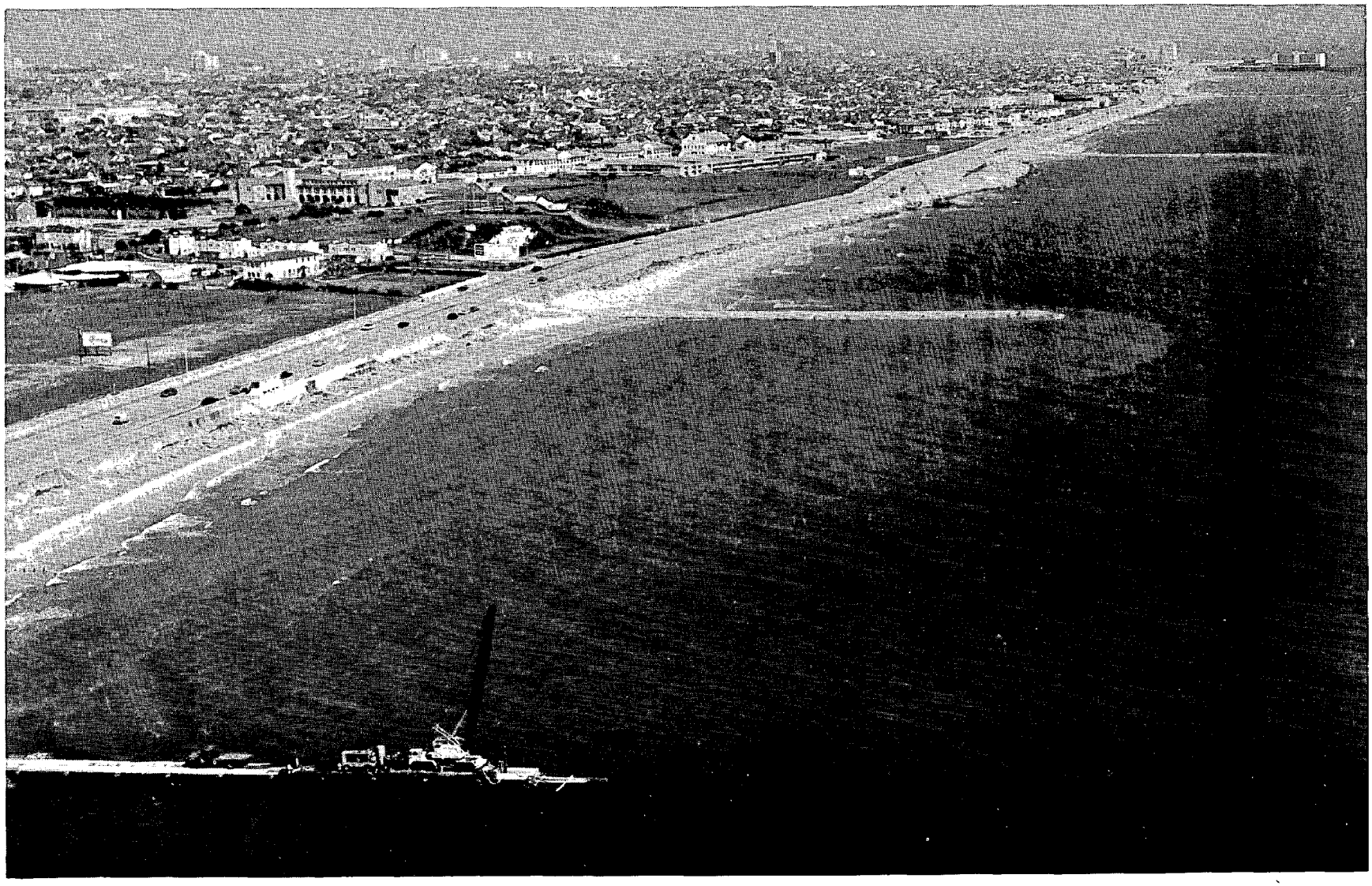
PHOTOGRAPH I - Stewart Beach on East Galveston Island In Zone B. Shows heavy utilization of beach in a regulated area.

by a massive concrete seawall. A system of 11 rock groins constructed by the Federal Government and four rock groins constructed by Galveston County protect about 4 miles of the seawall from erosion and stabilize the beach to a considerable degree. Photograph 2 shows a portion of the seawall and rock groins. Most private property along the seawall is highly developed with hotels, motels, apartments, restaurants, tourist attractions and other businesses. A few permanent residences are located immediately behind the seawall. Some beach bathing facilities, motels, concessions, amusements and a trailer park are situated on the unprotected part of the beach in front of the seawall at the east end of the island. The north portion of the city of Galveston and the south shore of nearby Pelican Island are occupied by marine and industrial facilities related to the deep-water harbor, and by businesses related to fishing, shipping and offshore oil exploration. The westerly two-thirds of Galveston Island is unprotected from hurricane surges. The area is rapidly changing from sparsely settled grazing lands to subdivisions for summer and permanent homes. Follet's Island, west of San Luis Pass, is about 9 miles long and is occupied by many permanent and summer homes.

Zone C.- Shoreline development of the eastern half of Zone C consists of permanent and summer homes and recreation-oriented businesses which cater to the many fishermen and bathers who visit the beach. The city of Freeport and its adjacent heavily industrialized area are located in Zone C. The reach of Zone C westward of the Freeport Harbor navigation entrance is mostly undeveloped, since it is accessible only by a single road and pontoon bridge across the Gulf Intracoastal Waterway. The beach does, however, receive some recreational use.

Zone D.- The northeasterly end of the Gulf shore in Zone D is undeveloped. It is a remote area and not easily accessible. The area is used for camping, bathing, and fishing when beach travel conditions permit. The Cedar Lakes area is undeveloped. Some small Gulf shore areas near the mouth of Caney Creek are subdivided for beach homes. Matagorda Peninsula, southwest of the mouth of Caney Creek, is used mostly for grazing. Numerous summer homes are located in the more accessible areas near the mouth of the Colorado River, where the beach is excellent for bathing and surf fishing. The shores of Matagorda Bay, east of the Colorado River, are generally undeveloped.

Zone E.- Matagorda Peninsula has the only Gulf shore in this zone. The peninsula, accessible only by boat or aircraft, is used primarily for ranching and recreation. Overnight camping is quite popular in the area of good fishing near the Matagorda jetties. Two private airstrips are located on the peninsula. Most of the perimeter of Matagorda Bay is sparsely populated marshland devoted to grazing except for the town of Port O'Connor and other small communities on the western shore. The western shore generally has sand and shell beach areas which are used considerably for recreation where public access is available. The bay shore of Port O'Connor is protected from normal wave action by a concrete



PHOTOGRAPH 2 – Center part of Galveston Seawall. Groin in foreground being rehabilitated (1968).

bulkhead about 4,200 feet long. Near Well Point, on the north shore of Matagorda Bay, about 1,200 feet of the shore is occupied by the Texas Parks and Wildlife Marine Biology Laboratory. Farm and ranch lands border a large portion of Tres Palacios Bay shoreline. The bay shore of the town of Palacios is partially protected by a concrete seawall, about 4.5 feet high and about 3/4 of a mile long. Twelve short groins extend from the seawall into the bay. The south part of the east shore of Lavaca Bay is low, undeveloped land. The remainder of the shore is comprised of banks and bluffs up to 25 feet high, except for some marsh areas at the mouths of several streams entering the bay. The city of Port Lavaca is the largest populated area on the bay. A considerable portion of the city's shore is protected against erosion from normal waves by bulkheads and rubble revetment.

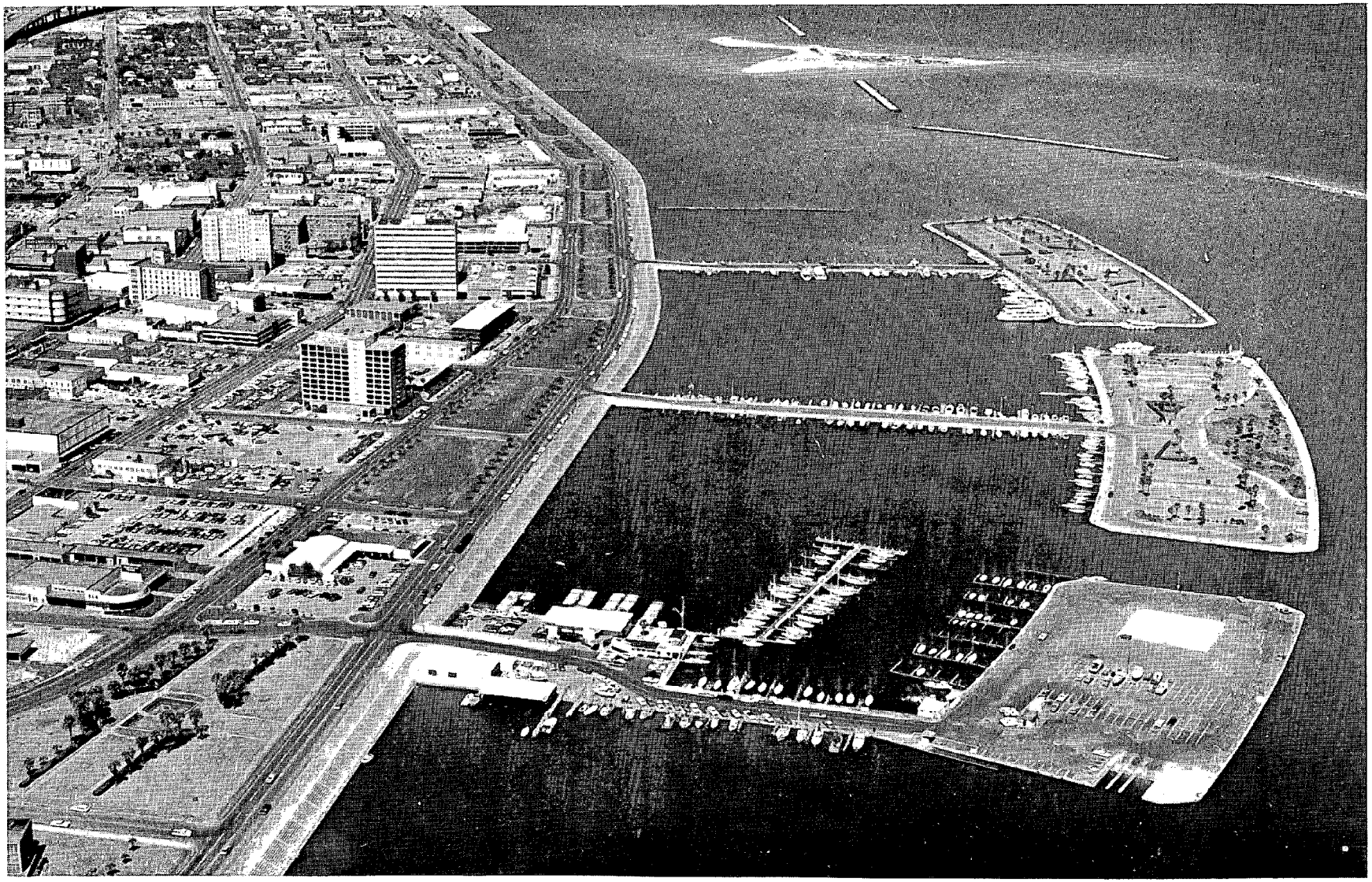
Zone F.- Matagorda Island is a remote area accessible only by boat or aircraft. About 60 percent of the 30-mile long island is occupied by the Matagorda Island Air Force Base and Gunnery Range. The southwestern end of the island is devoted to ranching. Recreation on the island is limited to private interests and military personnel because of the limited accessibility and restricted areas. The shorelines of Espiritu Santo, San Antonio, Guadalupe and Hynes Bays are, for the most part, undeveloped. South of the town of Seadrift, the land is quite low and unsuitable for permanent-type structures. A low, concrete bulkhead protects about 3,700 feet of Seadrift's residential bay shore from wave erosion associated with strong south and southwest winds and minor tropical disturbances. Most of the upper part of San Antonio Bay is bordered by the low, marshy delta lands at the mouth of the Guadalupe River. Steep secondary banks up to 25 feet high rise above the river delta behind the normal shoreline. The west shore of San Antonio Bay is relatively high but undeveloped, except for the town of Austwell and a few scattered residences. The Aransas National Wildlife Refuge occupies the shore of San Antonio Bay from Webb Point to False Live Oak Point.

Zone G.- The major portion of St. Joseph Island is used for ranching and private recreation. A small portion of the southern tip of the island, adjacent to the Aransas Pass Navigation Channel, is owned by the Federal Government. Mustang Island extends from the Aransas Pass Navigation Channel to Corpus Christi Pass, a distance of about 16 miles. The 16-mile long beach front is a very popular recreational center for the south Texas region. Sand dunes up to 25 feet in height lie behind the beach front, except for a small number of areas where dunes have been breached by hurricane tides. The island provides a rather high degree of protection against hurricane tides and waves for the inland areas around Corpus Christi Bay. The island has numerous beach homes and water-oriented recreational type facilities. Port Aransas, located on the northern end of the island, is the only town on Mustang Island.

A causeway and ferry provide access to the northern end of the island, while the John F. Kennedy Causeway provides access to the south end. The north shore of Mesquite Bay and the east shore of Blackjack Peninsula are low and are part of the Aransas National Wildlife Refuge. The west bank of St. Charles Bay is undeveloped. The perimeter of Copano Bay has scattered developments of permanent-type homes, fishing and hunting camps, farm buildings, and oil field and supporting facilities. Most of the northwest shores of Aransas and Redfish Bays are well developed with permanent and summer homes. The cities of Rockport and Aransas Pass have many businesses catering to tourists, hunters, fishermen and other water-oriented recreationists. Much of the bay shore at Fulton and Port Ingleside is partially protected from erosion by several different types of privately constructed revetments. Oil fields and permanent and summer residences occupy the northeast shore of Corpus Christi Bay. The northwest shore of the bay, including the town of Portland, has several residential subdivisions on bluffs, which range up to 30 feet above sea level. Oil and gas wells, piers, and docks constitute the major development on the north shore of Nueces Bay. At the head of the bay, the shoreline is formed by the low, marshy delta lands at the mouth of the Nueces River. Much of the south shore of Nueces Bay is undeveloped and is used as a spoil area for dredging operations in the Corpus Christi Ship Channel.

Corpus Christi, the largest city on the Texas coast, fronts the west and south shores of Corpus Christi Bay with about 16 miles of highly developed and densely populated urban areas. Corpus Christi is an important seaport and industrial center for petroleum and agricultural products and is also a major tourist and convention center. Most of the 16-mile reach of shoreline is protected from erosion by breakwaters, seawalls, bulkheads, groins and riprap. Photograph 3 shows some of the protective structures and small boat harbor facilities along the Corpus Christi Bay front. A large part of the Oso Bay shoreline is a tidal flat and not developed to any great extent. The University of Corpus Christi occupies an island connected to the mainland by a causeway at the mouth of Oso Bay. Encinal Peninsula lies between Oso Bay and the mainland shore of Laguna Madre. Part of the Corpus Christi Naval Air Station, the residential and tourist community of Flour Bluff and a number of small slips and wharves serving sport and commercial fishing interests and service facilities for the nearby oil and gas fields are located along the Encinal Peninsula shore. Many boating supply, bait, and fishing tackle businesses and launching ramps are located along the John F. Kennedy Causeway which connects the mainland with the north end of Padre Island and the south end of Mustang Island.

Zone H.- Padre Island, a barrier island between the Gulf of Mexico and Laguna Madre, extends south along the lower Texas coast for about 113 miles, ranging in width from a few hundred yards to about 3 miles. Padre Island has wide, clean, sandy beaches backed by sand dunes up to 40 feet high. Grass flats, smaller dunes, and mud flats make up the area between the primary dunes and Laguna Madre. A typical Padre Island



PHOTOGRAPH 3 - Portion of Corpus Christi shoreline in Zone G showing protective structures and recreational facilities.

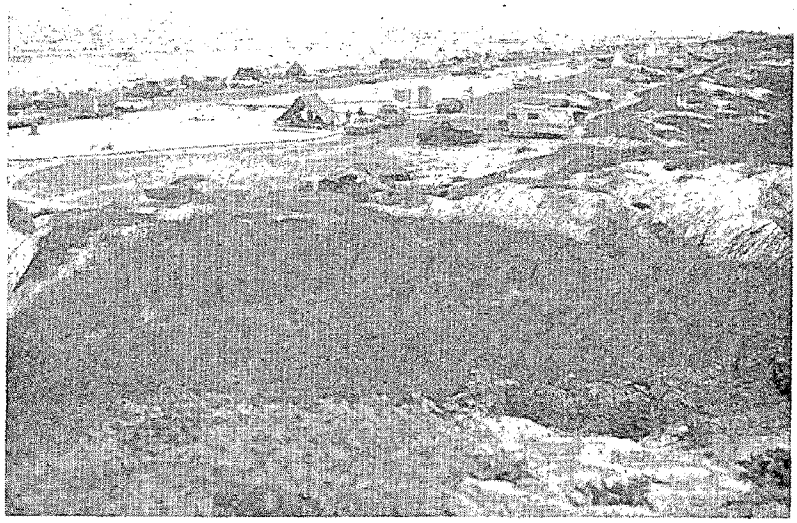
scene is shown in Photograph 4. The Federal navigation channel from the Gulf of Mexico to Port Mansfield extends through Padre Island about 38 miles north of Port Isabel. Most of the island north of the Port Mansfield Channel is occupied by the Padre Island National Seashore, a part 80.5 miles long dedicated to preserving that portion of the island in its natural state for the public's enjoyment. Each year its beaches provide recreation for a great number of people. Presently, there are camping and picnicking areas, an observation tower and a tourist center with additional facilities planned. The camping area and tourist center are shown in Photographs 5 and 6. Except for some public recreational and private residential and commercial developments at its northern and southern extremities, there are no other significant developments on Padre Island. The development at the north end includes a county park, fishing piers, several concession type businesses catering to bathers and beach users, an elaborate hotel complex and a subdivision for permanent and summer homes. A concrete seawall about 12 feet high protects the hotel. On the south end of Padre Island, along a length of about 5 miles, apartments, beach homes, motels, parks, restaurants and other tourist accommodations have been constructed. Photographs 7, 8, and 9 show typical recreation on South Padre Island.

The long mainland shore of Laguna Madre, extending south about 117 miles from Encinal Peninsula to Port Isabel, is essentially undeveloped privately owned land. The famed King Ranch occupies a substantial part of the shore along this reach. The area adjacent to the shore is largely unpopulated and has experienced less change during the past century than any other section of the Texas coast. Baffin Bay, about 30 miles south of Encinal Peninsula, has some private residences and recreational facilities along its west bank. Port Mansfield is a sport and commercial fishing center, with harbor facilities for fishing vessels and small craft. The community has a small number of permanent residents operating camps, motels, and businesses catering to tourists, hunters and fishermen. To the south, Laguna Atascosa National Wildlife Refuge borders a large portion of the Laguna Madre shore between the mouth of the Arroyo Colorado and a point about 8 miles north of Port Isabel. Between the wildlife refuge and Port Isabel, much of the area along the shore has been subdivided for permanent and summer homes. The Port Isabel waterfront is lined with hotels, motels, docks, piers, boat launching ramps and seafood handling and processing establishments.

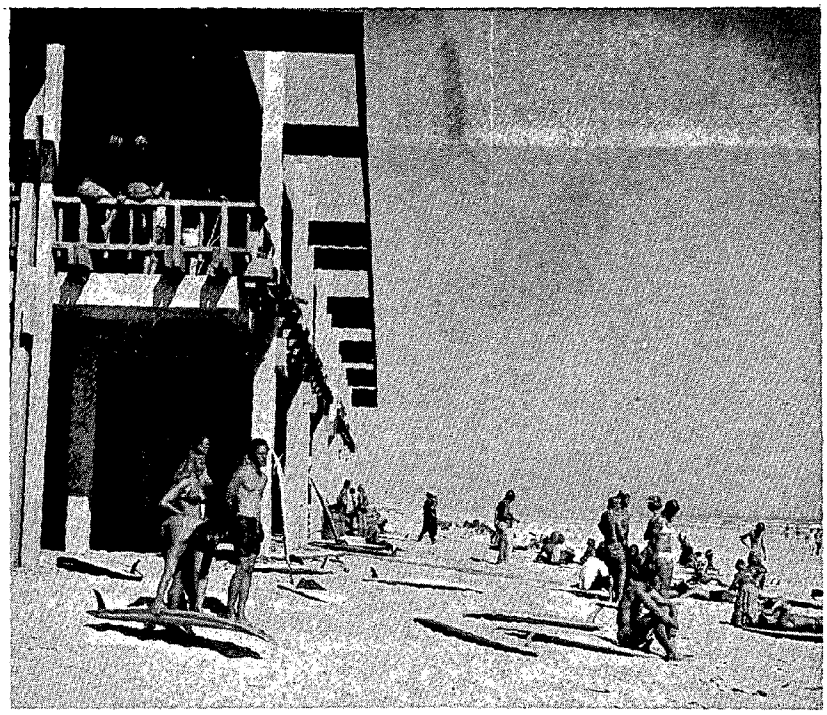
Brazos Island and the South Bay area between Port Isabel and the Rio Grande are mostly undeveloped. The Gulf shore of Brazos Island, including a 2-mile strip dedicated as a state park, is used for public recreation. Some private housing and a few tourist service establishments are located along this southern extremity of the Texas coast.

10. Future development. The shorelines of the Texas coast will continue to be of major importance in the economic and civic development of the state through their use for recreational, navigational, ecological,

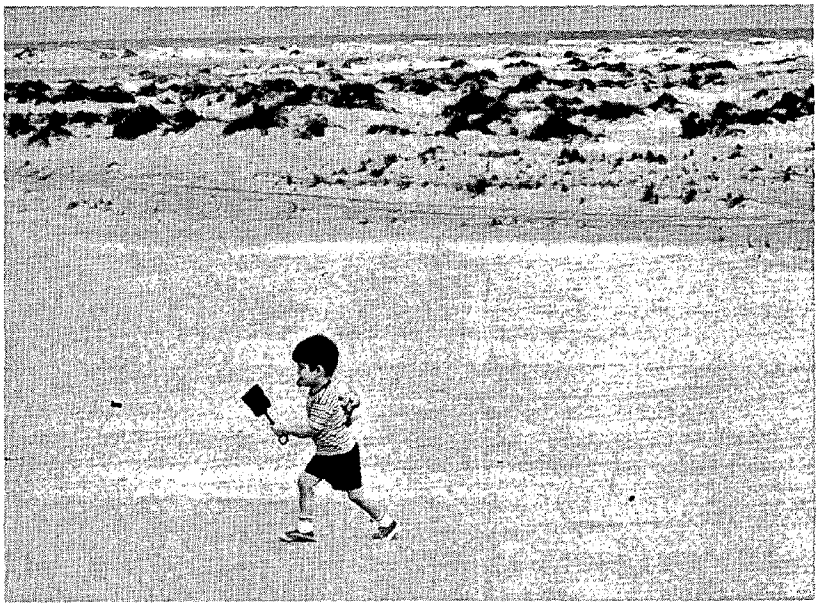
PHOTOGRAPH 4 - Family recreation on the beach of Padre Island National Seashore in Zone H. (National Park Service Photograph)



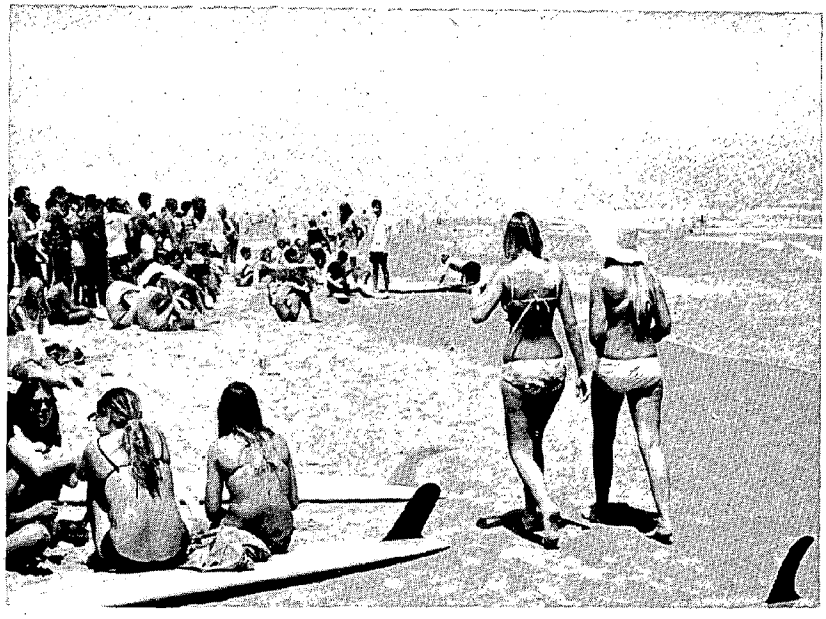
PHOTOGRAPH 5 - Campgrounds at Malaquite Beach along the Padre Island National Seashore. (National Park Service Photograph.)



PHOTOGRAPH 6 - Surfers congregated at the Padre Island National Seashore Tourist Center on Malaquite Beach. (National Park Service Photograph)



PHOTOGRAPH 7 - A lad enjoying the wide sandy beach of South Padre Island, (Photograph courtesy of South Padre Investment Corp.)



PHOTOGRAPH 8 - Heavy utilization of beach during surfing contest on South Padre Island. (Photograph courtesy of South Padre Investment Corp.)

PHOTOGRAPH 9 - Fisherman on South Padre Island. (Photograph courtesy of South Padre Investment Corp.)

industrial, commercial and residential purposes. It is anticipated that an increasing number of industrial installations will seek to locate along the shoreline, competing with other private interests for valuable land and posing an increasing threat to the natural ecology of the area. The pattern of development of privately owned shoreline has been to first utilize the more desirable land that is readily available and accessible, with growth extending into less desirable areas as demand increases. The continuing pressures of development indicate eventual development of substantially all of the shoreline, except those areas owned or controlled by the various public agencies.

11. Littoral transport. Throughout most of the year the prevailing winds along the Texas coast are from the south and southeast. From the Louisiana border, the coastline extends generally southwest to the coastal bend area in the Corpus Christi vicinity, and from that point generally south to the Mexican border. With this shoreline configuration, the waves generated by the south to southeast winds produce a net littoral transport from northeast to southwest along the upper coast, and from south to north along the lower coast. Frequently during the winter months, and occasionally during other seasons, changes in wind directions reverse the directions of littoral transport for short periods of time. The general littoral movements of beach and shore materials along the Gulf shore are interrupted both by artificial structures and by tidal currents through passes between the Gulf and inland bays. Major natural passes exist at Sabine Pass, Galveston Bay entrance, San Luis Pass, Pass Cavallo, Aransas Pass and Brazos Santiago Pass. Four of these - Sabine Pass, Galveston Bay entrance, Aransas Pass and Brazos Santiago Pass - have been improved for deep-draft navigation and have stone jetties extending considerable distances into the Gulf of Mexico. Similar jetties have been provided for improved navigation channels at the old Brazos River entrance near Freeport, Matagorda Ship Channel entrance through Matagorda Peninsula near Port O'Connor and the Port Mansfield Channel entrance through Padre Island north of Port Isabel. In addition to those mentioned above, there are permanent openings in the shoreline at the mouth of the Brazos River Diversion Channel, San Bernard River and the Colorado River. An authorized navigation improvement of the mouth of the Colorado River will provide jetties extending into the Gulf. Rollover Pass, a former intermittent or wash-over pass through Bolivar Peninsula, has been improved for tidal exchange and passage of fish between East Bay and the Gulf and is now permanently open. A number of other intermittent passes at various locations are opened when hurricanes cross the coast. Following the storm, these passes may remain open for periods ranging from a few weeks to several years before being closed by natural shore processes. Two of the more permanent passes of this nature are Brown Cedar Cut and Greens Bayou, both connecting Matagorda Bay with the Gulf through Matagorda Peninsula. Brown Cedar Cut, which has remained open since Hurricane Carla in 1961, is shown in Photograph 10.

PHOTOGRAPH 10 - Brown Cedar Cut through Matagorda Peninsula in Zone D, illustrates a typical storm pass.

The natural and man-made passes and channels disrupt the normal longshore drift by increasing the deposition adjacent to and in the passes. All of the navigation entrances are maintained periodically by hopper dredges, with the excavated material being deposited in deeper water several miles offshore in the Gulf. Other factors affecting the rate and volume of littoral transport are the sediments carried to the Gulf by the major rivers along the coast and the longshore currents affecting movement of materials within the littoral zone. For the most part, nearshore currents parallel the coast and move from the upper coast toward the lower coast. Farther offshore, the Gulf stream moves in the opposite direction. Along the upper coast, the Sabine, Neches and Trinity Rivers carry mostly fine sediments to the coast and do not supply significant volumes of sands to the beaches and shore. The Brazos, Colorado and intervening rivers southward to the Rio Grande carry larger percentages of sandy materials and during flood periods, contribute considerable sand to the Gulf and its shore processes. In the coastal bend area between Pass Cavallo and Aransas Pass, littoral transport is subject to reversal more frequently than along the remainder of the coast and at times, fine materials are probably lost directly offshore in those reaches where the approach direction of prevailing waves is approximately normal to the shoreline.

SHORE HISTORY

12. Nature of erosion. Surveys of record indicate that the 251-mile Gulf shoreline between Sabine Pass and the southern end of Mustang Island (Zones A through G) has generally been accreting near the Galveston entrance and Aransas Pass and near the mouths of streams emptying directly into the Gulf. However, the shoreline has generally been eroding near Sabine Pass, San Luis Pass and Pass Cavallo and near the smaller intermittent inlets of Brown Cedar Cut and Greens Bayou. Approximately the middle one-third of the reaches of shore between stream mouths and openings have for the most part experienced some erosion.

Comparison of historical maps for the period 1882 to 1951 show that intermittent erosion and accretion have occurred in Zone H along Mustang and Padre Islands, although little or no net change in the shoreline has resulted during the period of record. Since the latter part of the nineteenth century, there has been continuing erosion of the sand dunes on all the barrier islands and peninsulas, particularly on Mustang and Padre Islands. This erosion is most pronounced after storms in which winds and high tides force water through the lower areas breaching the weakest of the dunes, and resulting in the wash-over cuts or passes through the barrier islands and peninsulas. Between storms, the denudation of vegetation from overgrazing and traffic encourages wind erosion and leaves the dunes more susceptible to storm damage.

13. Over the period of record, most shore erosion around the perimeters of bays behind the barrier islands and peninsulas has been along the northern and western shores, which are more exposed to waves generated by the prevailing winds. The most rapid and dramatic changes in the shoreline are associated with hurricanes and other large storms. Under the intense wave attack accompanying these storms, unprotected bluff banks may erode 40 to 50 feet in a period of hours.

14. Classification of erosion. For the purpose of this inventory, shore erosion for specific localities has been classified as "critical" or "non-critical," considering the rate of erosion in conjunction with economic, industrial, recreational, agricultural, navigational, demographic, ecological and other relevant factors. Erosion was termed critical when evaluation of the above factors indicated that action to halt such erosion may be justified. Particular consideration was given to ecological factors in the bay areas where erosion is producing detrimental effects to areas of significant value to marine life. For example, in some locations erosion may cause a loss of shore habitat that is valuable as a nursery area for estuarine organisms, and may increase the turbidity and siltation of shallow waters near the area of erosion, with loss of valuable benthic organisms and aquatic vegetation. Also prime feeding and nesting areas for shore birds and migratory waterfowl may be lost.

15. Extent of erosion on Gulf shores. One of the more extensive areas of critical erosion along the entire Gulf shoreline of Texas is a reach of about 13 miles between the town of High Island and the Galveston entrance channel in Zone B. Based upon reliable historical information, it is estimated that the shore of this popular recreation area has receded at an average rate of more than 4 feet per year for over 50 years. A 1958 report of the Corps of Engineers entitled "Report on Beach Erosion Control Cooperative Study of the Gulf Shore of Bolivar Peninsula, Texas (Erosion at Rollover Fish Pass)," stated: "It is found that there is extensively active erosion along the Gulf Shore between High Island and a point 7 miles east of Galveston entrance that results in a deficiency of beach materials of about 200,000 cubic yards of material annually, and further, that construction of the fish pass (Rollover) has resulted in an increase in the deficiency of about 18,000 cubic yards annually." The state highway paralleling the beach has been relocated to the north three times in some locations because of encroachment caused by erosion. Photograph 11 shows that the present beach foreshore is close to the highway right-of-way marked by utility poles. The photograph also shows evidence of recent erosion of the weak sand bank. An aerial view of this area is shown in Photograph 12.

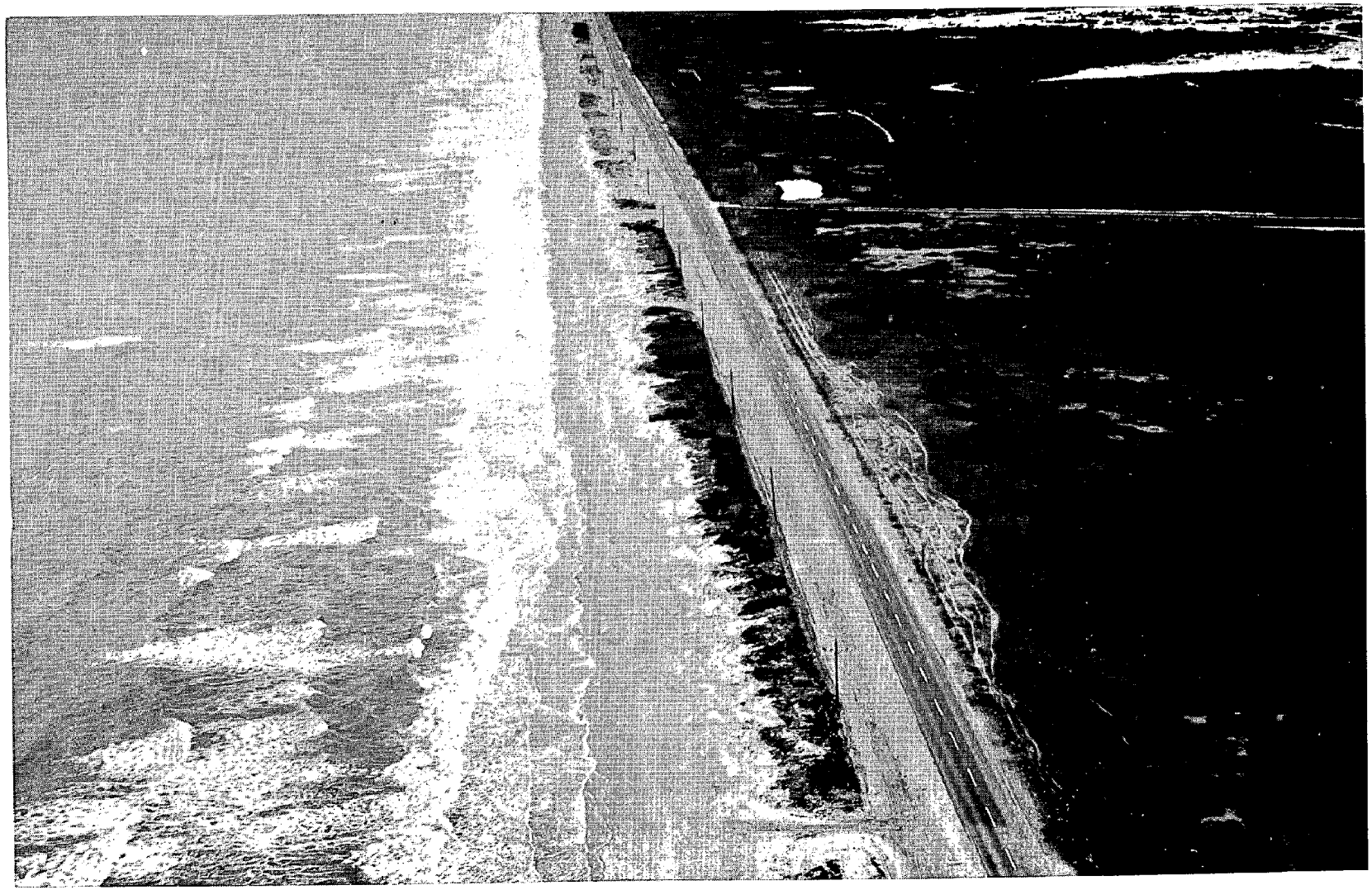
16. Another area of critical erosion along the Gulf beach exists in a 9-mile reach extending west from San Luis Pass in Zone B. The region is being developed rapidly for beach home sites. Photograph 13 taken near San Luis Pass, shows a house built close to the beach a few years ago. Without the protective structures shown in the photograph, the house foundation would now be in the water. Record maps indicate that part of the shoreline in this vicinity has eroded northward as much as 600 feet during the past 60 years.

17. A similar critical erosion area exists along a reach of about 6 miles on the Gulf coast near Caney Creek between the mouths of the Brazos and Colorado Rivers in Zone D. Local residents estimate erosion of the shore to be as much as 300 feet during the last 16 years. The foundation of the beach house shown in Photograph 14 was undercut by erosion during a period in which no abnormally high tides were experienced. Photograph 15 in the same vicinity shows remains of other beach houses which have been destroyed.

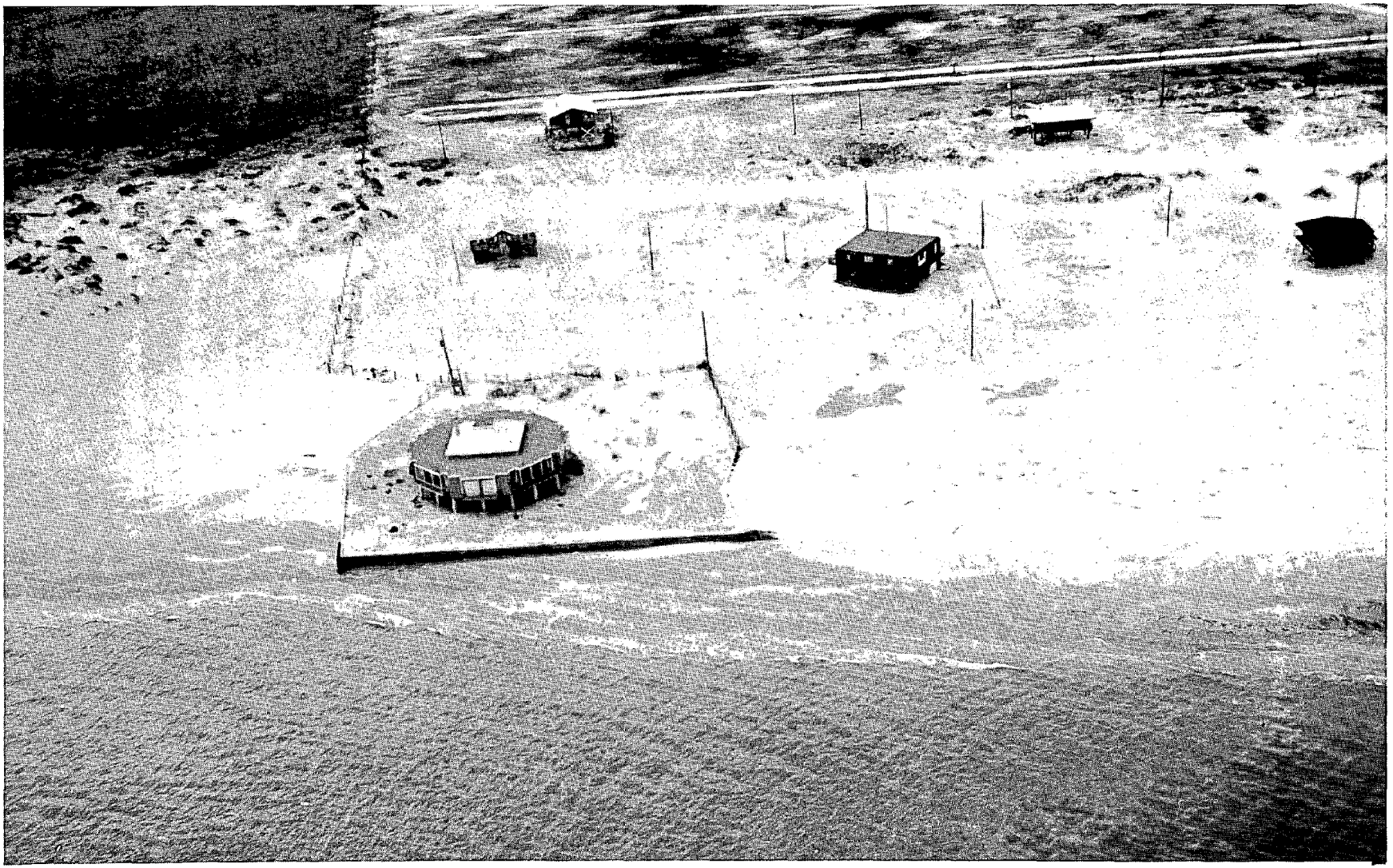
18. About 3 miles of eroding shoreline in front of the popular tourist and public recreation beach on South Padre Island in Zone H has been classed as "critical." Relatively large beach losses in this area have resulted from tropical storms.

19. Extent of erosion on bay and estuary shores. About 15 miles of the north shore of East Bay in Zone B is estimated to erode at an annual rate of 5 to 6 feet. About 6.5 miles of this area is the shoreline of the Anahuac National Wildlife Refuge. The remainder is ranch land. Photograph 16 shows a typical example of the eroding shore in this area.

PHOTOGRAPH 11 - Near High Island in Zone A.
Utility poles on highway right-of-way.
Sparse vegetation line eroding.

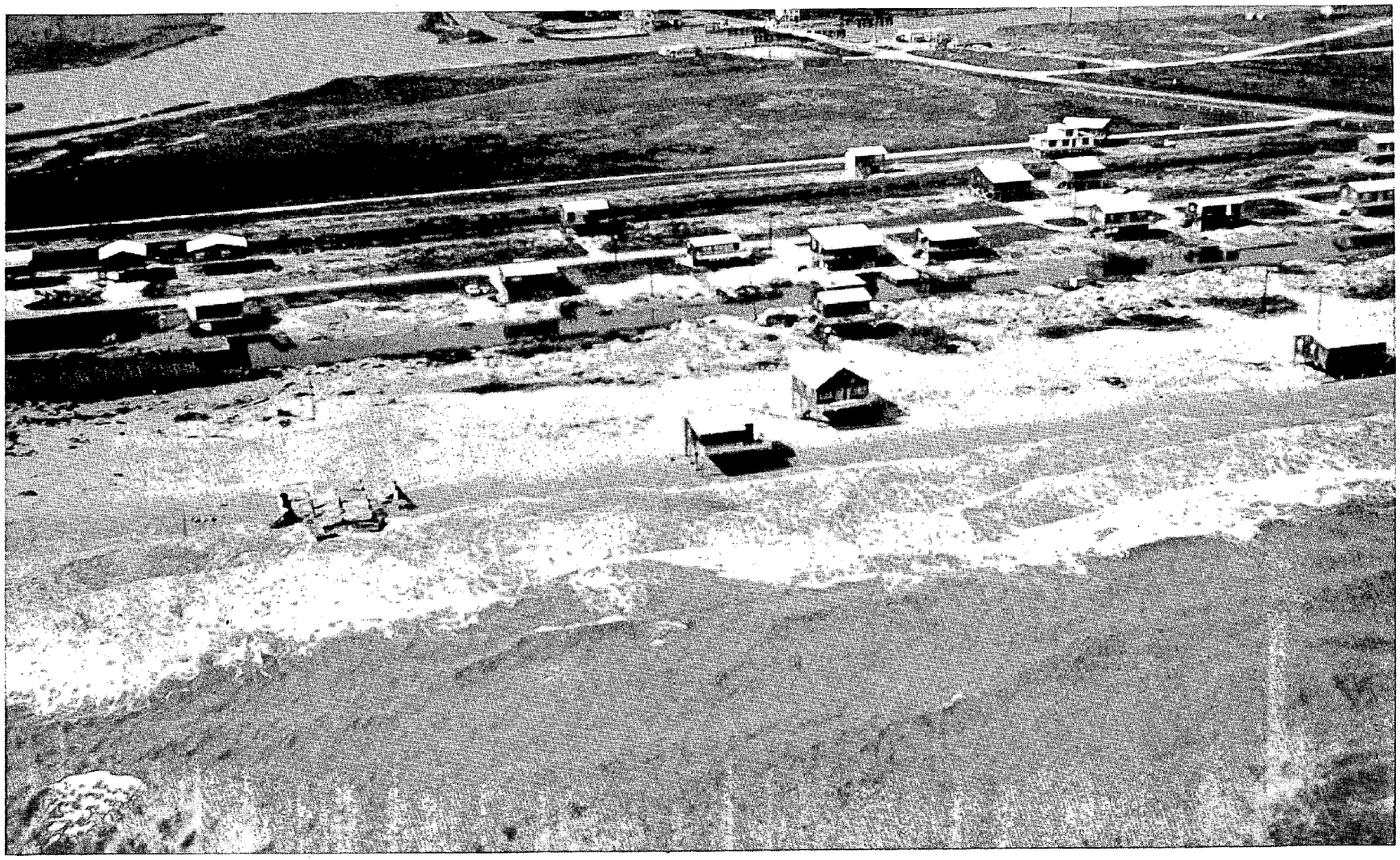


PHOTOGRAPH 12 - Eroding Gulf shoreline encroaching on State Highway 87.



PHOTOGRAPH 13 - Property owner combats beach erosion near San Luis Pass in Zone B.

PHOTOGRAPH 14 – Sargent Beach near mouth of Caney Creek in Zone D.
Beach homes shown have been abandoned due to critical erosion.



PHOTOGRAPH 15 - Gulf shore at Sargent Beach with Gulf Intracoastal Waterway in background. View of severly eroding beach where many shore front lots and beach houses have been lost to severe erosion.

PHOTOGRAPH 16 - North shore of East Bay in Zone B on Anahuac National Wildlife Refuge. Erosion rate up to 6 feet per year.

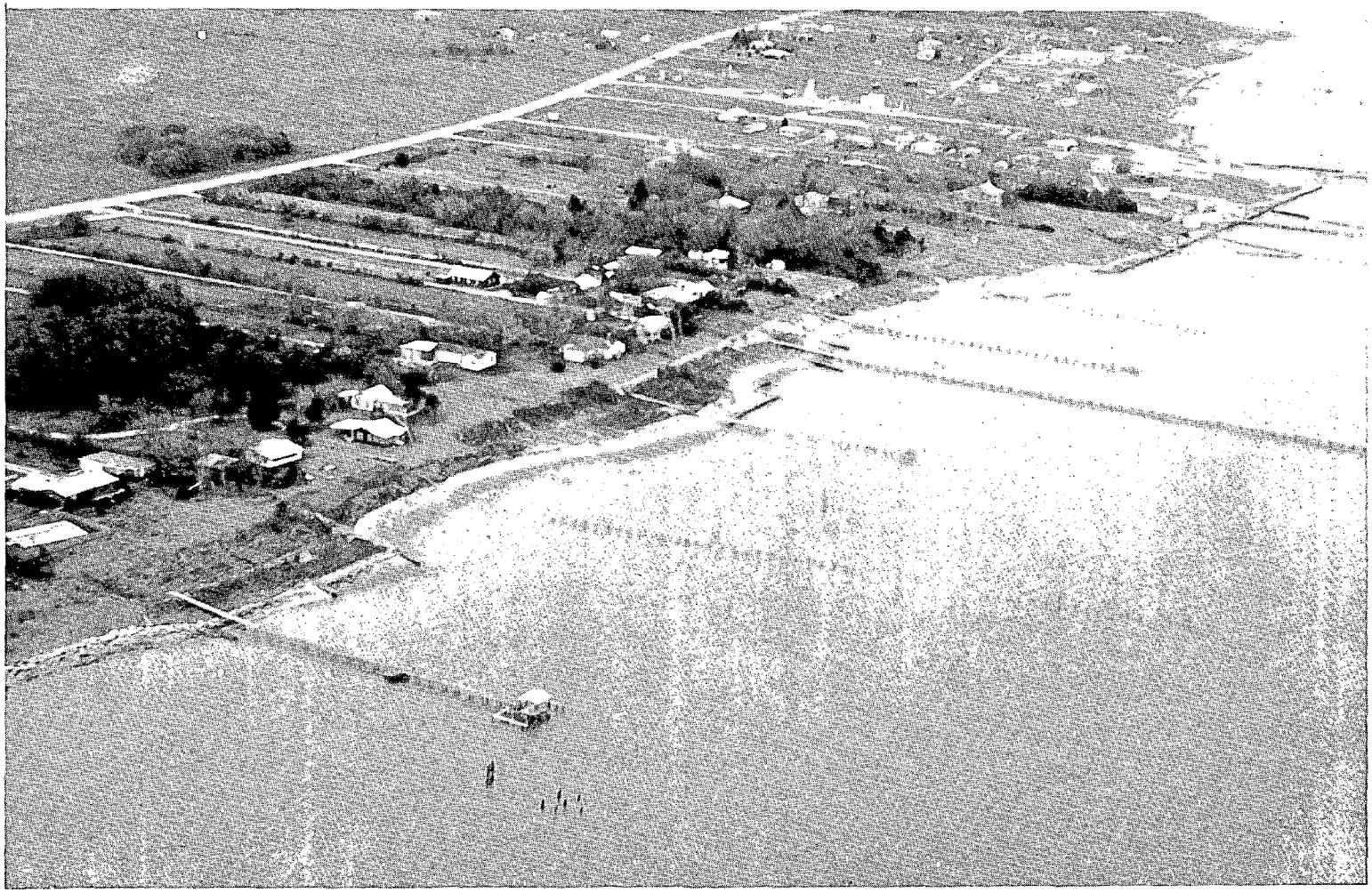
Portions of the west shore of Trinity Bay and north and west shores of Galveston Bay have been partially protected from erosion by private land owners. The effectiveness of these structures ranges from poor to good. However, the areas have been classified as "critical" because of the rapid and continuing development on the high banks which are in great demand for homesites. Many of the protective structures consist of rubble or bulkheads placed along the shoreline which retard the erosion during normal conditions, but afford little protection to the high banks during exposure to hurricane generated tides and waves. In many of the eroding areas it appears that the erosion has been aggravated by protective measures undertaken in adjacent areas. Typical areas with random protection are shown in Photographs 17, 18, 19 and 20.

20. At the upper end of Tres Palacios Bay in Zone E, and intermittently around the perimeter of Carancahua Bay, a total of about 18 miles of high banks is occupied by farms, ranches and homesites. Erosion of these banks has been estimated to average about 3 feet per year. Photograph 21 shows a typical section of the eroding bank along the east side of Carancahua Bay. A reach in this same area, which has recently been protected, is shown in Photograph 22.

21. The erosion along 10 miles of the west shore of Lavaca and Matagorda Bays in Zone E, used mostly for ranching and to a lesser extent for homesites, has been classed as "critical." Over a 2-mile portion of this reach, as much as 150 feet of erosion during the last 10 years has been reported. Photograph 23 shows property at the southern edge of the city of Port Lavaca, where the shore has been partially protected from erosion by rubble. The unprotected bank of the lot in the background erodes an average of about 2 feet a year during normal conditions. About 20 feet of the same bank was lost in 1961 during Hurricane Carla.

22. Nearly 17 miles of developed shoreline around the ends of Lamar and Live Oak Peninsulas in Zone G experiences critical erosion. During Hurricane Carla, one reach of shore on Copano Bay eroded as much as 50 feet. It is reported that along Fulton Drive on the east shore of Live Oak Peninsula as much as two blocks of subdivided property have eroded into the water during the last 70 years. Photograph 24 shows rubble placed on the banks which partially protects the popular 3-mile long scenic drive, where the adjoining property occupied by homes and small businesses, is valued at about $160 per front foot.

23. Only one area along the shores of Corpus Christi Bay has been classified as critical erosion. Known locally as North Beach, the area extends about 1.4 miles along the west shore of Corpus Christi Bay, near Rincon Point, in Zone G. Today the shoreline lies several hundred feet landward of that indicated by an 1868 survey. A Federal project to provide restoration and protection for this area has been authorized. Additional information concerning this project is provided in paragraph 26.



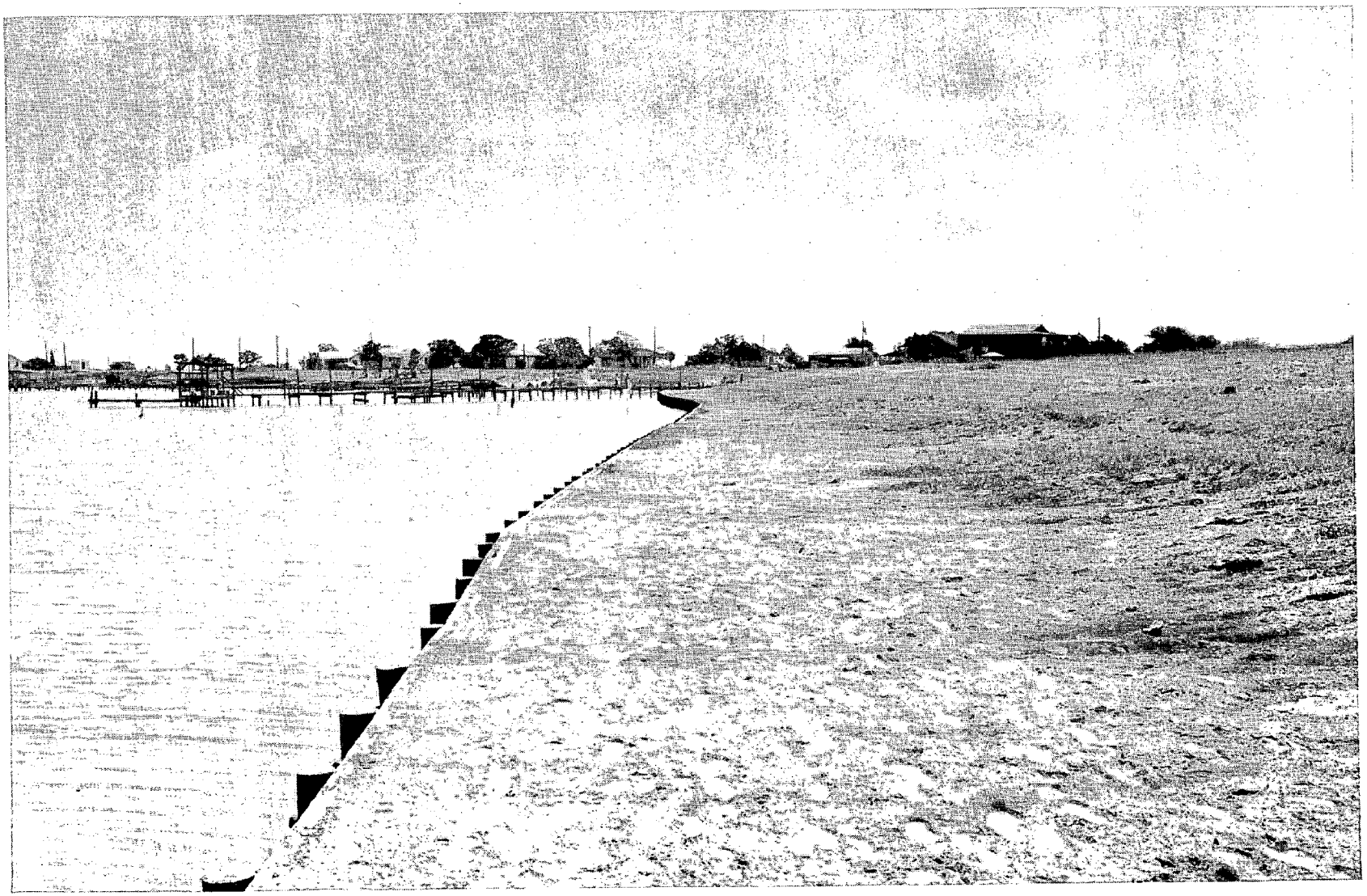
PHOTOGRAPH 17 - West shore of Trinity Bay in Zone B. Unprotected reaches are experiencing critical erosion in this area.

PHOTOGRAPH 18 - West shore of Galveston Bay in Zone B, near La Porte, Texas, showing critical erosion in unprotected reaches. House adjacent to the eroding bank has been abandoned.

PHOTOGRAPH 19 - West shore of Galveston Bay in Zone B, near Kemah, Texas, showing critical erosion occurring between protected reaches.

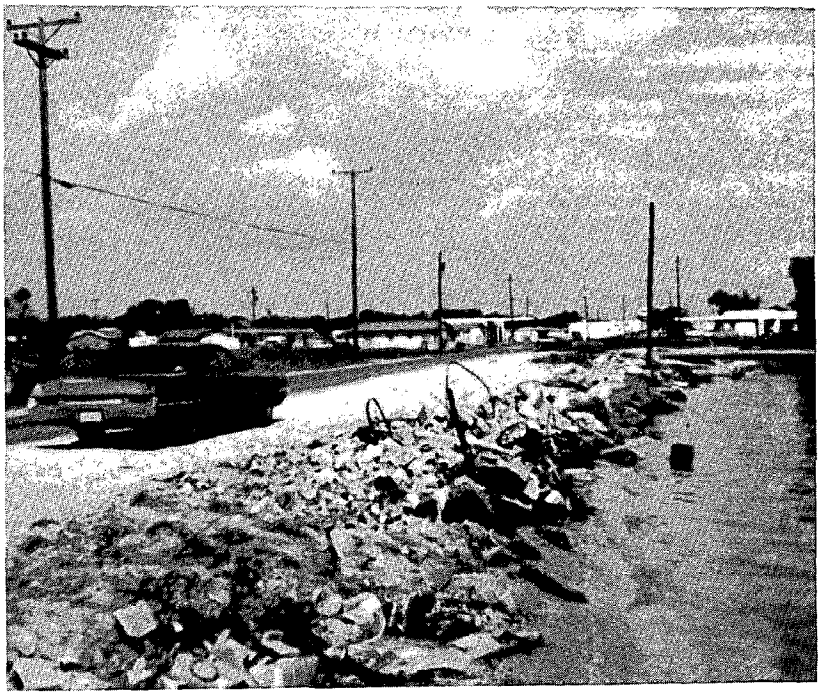
PHOTOGRAPH 20 - Galveston Bay shore at San Leon, Texas, showing intermittent protected and unprotected eroding shoreline.

PHOTOGRAPH 21 – East bank of Carancahua Bay in Zone E. Valuable land eroding about 3 feet per year.



PHOTOGRAPH 22 – Timber bulkhead protecting a segment of the east shore of Carancahua Bay.

PHOTOGRAPH 23 - South of city of Port Lavaca, Zone E. Unsightly rubble partially protects some shore. Unprotected portion erodes an average of about 2 feet a year.



PHOTOGRAPH 24 - Near Fulton on Aransas Bay, Zone G. Rubble protects popular shoreline drive from erosion during times of normal wave action.

AUTHORIZED FEDERAL PROJECTS

24. Description. The largest authorized and constructed Federal project on the Texas coast pertaining solely to shore erosion prevention and control is the Galveston Groin System. That project, comprising a system of 13 groins extending into the Gulf along a 3.8 mile portion of the Galveston Seawall, was authorized by the River and Harbor Acts of August 30, 1935, and April 4, 1938. The original groins were completed in 1939 as low steel sheet pile and timber pile structures, about 500 feet long and spaced about 1500 feet apart. Because of deterioration of the original groins, the groin system was redesigned and completely rehabilitated, with the work being completed in June 1970. The Federal system now includes 11 rubble mound groins with minimum crown elevations of 6.5 feet above mean low tide. Ten of the groins are 500 feet long, and one is 300 feet long. The total cost of both construction and rehabilitation of the Federal system was borne by the Federal Government. The cost of the original groins was $303,650; and the cost of the rehabilitation program was about $1,450,000.

25. The Texas City and Vicinity Hurricane-Flood Protection Project affords some protection to shores in that vicinity. A completed earthen levee section protects about 2 miles of the Galveston Bay shoreline and partially protects about 9 miles of the shorelines of Moses Lake and Dollar Bay. The authorized La Marque-Hitchcock Extension to the above project, when constructed, will partially protect about 4 miles of Jones Bay shoreline.

AUTHORIZED FEDERAL SURVEY STUDIES

26. Description. In addition to studies for the Galveston Seawall groin system, the Corps of Engineers has made 6 other survey studies on the Texas coast, in which erosion problems were the primary concern. Several other studies, primarily for other purposes, but with secondary consideration of shore erosion problems, have been made or authorized. Titles and summary information on the pertinent studies are as follows:

a. "Shore Protection of Galveston Bay, Harris County, Texas," published in 1935 as House Document No. 74, 74th Congress, 1st Session. The study was made by the Beach Erosion Board in cooperation with the Commissioners Court of Harris County, Texas. The report found no Federal interest in construction of remedial measures for the problem area but did present a plan and cost estimates for protection of the shore front by construction of steel or creosoted wooden pile bulkheads. The plan was not implemented for construction by the local government agency.

b. "Gulf Intracoastal Waterway (Erosion at the east end of Bolivar Peninsula)". This study was authorized to investigate erosion problems that allegedly had been caused by construction of the Gulf Intracoastal Waterway. The report, prepared in 1950, concluded that the erosion had resulted from natural forces and had not been aggravated by any waterway improvements constructed by the Federal Government. The report was transmitted to Congress with an unfavorable recommendation for a Federal project. It was not published.

c. "Gulf Shore of Galveston Island, Texas; Beach Erosion Control Study," published in 1953 as House Document No. 218, 83rd Congress, 1st Session. The report found that active erosion requiring remedial measures existed along a 2.2-mile reach of the Galveston Island Gulf shore in front of the recommended seawall extension. However, the report also found that, under statutory authority existing at that time, there was no Federal interest in maintenance of the shore; and it was recommended that no Federal project be adopted.

d. "Shore of Galveston Bay, Galveston County, Texas," published in 1954 as House Document No. 346, 83rd Congress, 2nd Session. The study was made in cooperation with the Commissioners Court of Galveston County and covered erosion problems along the Galveston County shore of Galveston Bay between April Fool Point and Kemah. Eight alternative plans of protection

were studied, and it was concluded that the most feasible and economical plan would provide for a dumped mound of quarry-run limestone on a shell filter blanket base. The report concluded, however, there was no Federal and very little non-Federal public interest in the protection of the shore because of ownership of the lands. The report recommended that a Federal project for protection of the shore of Galveston Bay not be authorized.

e. "The Gulf Shore of Bolivar Peninsula, Texas (Erosion at Rollover Fish Pass)" prepared in 1958 and published in 1959 as House Document No. 286, 86th Congress, 2nd Session. The study was made in cooperation with the State of Texas to determine the best method of erosion control on the Gulf shore in the vicinity of Rollover, Texas, and the best way to stabilize Rollover Fish Pass which had been constructed by the State Game and Fish Commission of Texas. Relative to shore erosion, the study found active erosion of about 14-miles of the Gulf beach of Bolivar Peninsula but concluded that there was no Federal or non-Federal public property subject to erosion damages and, therefore, no Federal interest in the proposed improvement. A plan of improvement for stabilizing Rollover Fish Pass was developed which provided for construction of submerged-wier sills across the pass, side bulkheads with toe stabilization and periodic nourishment of the adjacent Gulf beach area to offset shore erosion. The improvements were constructed by the Texas Game and Fish Commission in 1959 and have maintained the stability of the pass since that time. However, the recommended periodic nourishment of beach areas to the southwest has not been performed and the downdrift shoreline continues to erode.

f. "Survey Report on Corpus Christi Beach (Restoration Project)," published as House Document No. 91-415. The project was authorized under the provisions of Section 201 of the Flood Control Act of 1965 in December 1970. The project provides for restoration of 1.4 miles of recreational beach by construction of a hydraulic fill base and plating with a coarse sand and subsequent periodic nourishment. The initial cost and the first 10-year period of nourishment costs would be shared equally by the Federal Government and local interests. The estimated first cost to the Federal Government is $705,000 for the new work, with an estimated annual maintenance cost of $36,000 during the first 10 years of project life.

g. "Aransas Pass and Vicinity, Texas." This study was authorized in February 1971 to survey the Aransas Pass area in the interests of beach erosion control, hurricane protection and related purposes. No funds have been provided for the study up to this time.

h. "Burnett, Crystal, and Scotts Bays and Vicinity, Baytown, Texas." This study, authorized by an item in the Flood Control Act of 1968, provides for a survey of the named areas in the interests of flood control, drainage and related water and land resources, including specifically the problems of general subsidence of the area and the flood problems created thereby. The study was started in 1971.

i. "Texas Coast Hurricane Study." This is a comprehensive hurricane flood protection study of the Texas Gulf coast to determine the feasibility of providing protection from hurricane flooding on a unitized basis to long reaches of the coastal area and secondary protection to localized areas. Such a system would afford substantial protection to presently developed areas as well as those that would be developed in the future, and would greatly simplify the local protection problem where such protection might still be found necessary. The overall study is scheduled to be completed in 1977. For study purposes, the Texas coast has been divided into five study areas centered generally around the five major bay areas. In study sequence, these are the Galveston Bay area, Matagorda Bay area, Corpus Christi Bay area, the Sabine Lake area, and the Laguna Madre area. The study was commenced in the Galveston Bay area, which is the most highly developed. A feasibility study of the Galveston Bay area found strong justification for the comprehensive hurricane flood protection system. An interim survey scope study of the area is scheduled to be completed in 1973. Feasibility studies are now being made in the Matagorda and Corpus Christi Bays and will be commenced in 1973 in the Sabine Lake and Laguna Madre areas. If results of these feasibility studies are favorable, these will be followed by survey scope studies. The protection systems under consideration in the study generally would provide for primary protection systems along the general Gulf shoreline, with alternate plans differing from the primary system plans mostly in alignments. Each system would provide for a continuous line of protection consisting of levees, seawalls, gated navigation closure structures, gated openings for normal tidal exchange, drainage outlet facilities, pumping plants, etc. In concept, the primary protection system would prevent most of the Gulf hurricane tidal surge from entering the bay systems.

Investigations made during this study indicate that a considerable amount of erosion that has occurred is attributable to hurricane surges and waves. A reduction in the erosion caused by hurricanes would result from the protection provided by the planned-protection system, particularly in the high bluff shoreline areas where hurricane surges and waves usually accelerate erosion.

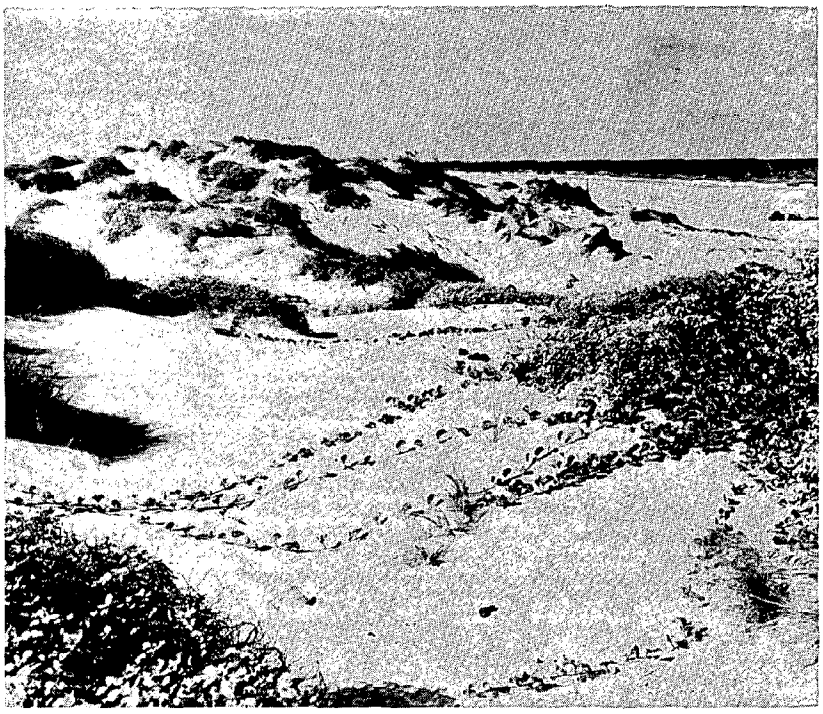
IMPROVEMENT METHODS

27. Gulf shores. Where sufficient sand is available from nearby sources, periodic nourishment of eroding beaches is often the most economical and satisfactory method. With this method a stockpile supply of sand is usually deposited at the upper end of the eroding section to be distributed to the downdrift beach areas by the natural littoral transport processes. Strategically located groins sometimes offer a practical solution for localized areas, where appreciable amounts of littoral material are transported by nearshore currents and where trapping of materials within the groin area will not introduce severe erosion problems in other downdrift areas. Often a combination of beach nourishment and groins offer a suitable remedy to eroding beaches. In some cases where such problems would be encountered, the effect on downdrift beaches can be minimized by artifically nourishing the groin system to near capacity initially.

28. A line of high sand dunes, such as that shown in Photograph 25, with continuous vegetation along the barrier islands would provide significant protection to the barrier islands, as well as to the mainland, from storm surges and hurricane generated waves. The Corps of Engineers is participating with several other organizations in a research project on Padre Island to develop economical methods of reconstructing and stabilizing primary dune areas. In this project, various mechanical methods and various types of vegetation are being tested for ability to trap and hold moving sand to create and stabilize dunes. Typical native vegetation in a dune area on South Padre is shown in Photograph 26.

29. Bay and estuary shores. In bay areas used for bathing, periodic replenishment of eroded beaches is often the most desirable solution. Although relatively expensive, many reaches of the bay shores not used extensively for bathing can be efficiently protected by bulkheads, reinforced concrete stepped walls or riprap revetments. In some areas, adequate protection may require structural measures in conjunction with beach replenishment. If structures are required, they should be continuous along the entire reach of shore to be protected. Substandard and haphazardly planned and spaced structures often interfere with natural shore processes and can severely aggravate erosion of adjacent areas. In areas of valuable estuarine habitat, structural measures may be more detrimental than the actual erosion. The placement of structures along the shoreline may eliminate nursery habitat for estuarine animals, alter the upland nutrient laden drainage, displace feeding habitat for birds and small animals, and depending on the location, may eliminate benthic organisms essential to the food chain of the marine fishery.

PHOTOGRAPH 25 - Typical dune along Gulf shore of South Padre Island, in Zone H, with native vegetation. (Photograph courtesy of South Padre Investment Corp.)

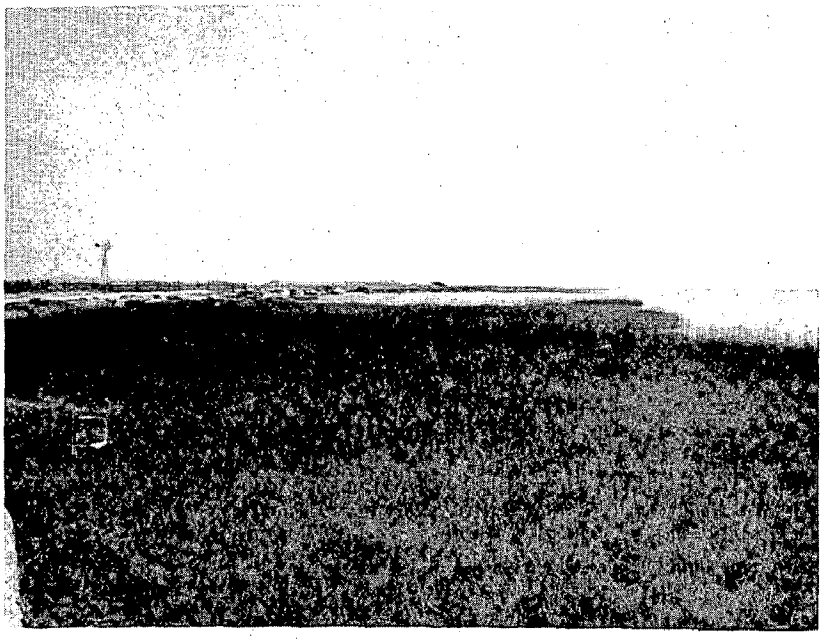


PHOTOGRAPH 26 - Typical native vegatative cover in a dune area of North Padre Island, in Zone H. (National Park Service Photograph.)

30. A method that may offer an economical means of controlling erosion and restoring bay shores, as well as providing significant ecological benefits, is vegetative plantings. Photograph 27 shows the initial planting of smooth cordgrass (Spartina Alterniflora) in an experiment conducted by the Soil Conservation Service along the north shore of East Bay in Area B. The few rows of sprigs, hand planted in 1957, between mean high and low tides, have developed without fertilization or special care and by 1970 have transformed the areas, as shown in Photograph 28. Over this period, the elevation of the area now covered with grass has been raised about one foot by accretion. Continued erosion of the adjacent area was shown in Photograph 16.

31. Estimated costs. Construction costs for erosion protection are quite variable, depending upon type, location, size, purpose and other considerations. For example, average initial costs for restoration of beaches along the Texas coast through fill operations are estimated to range from about $60 to near $200 per linear foot of shore. The lower cost would be for an area with a nearby supply of sand for nourishment which could be dredged and placed hydraulically. The higher figure would represent the nourishment of an area which would require a truck haul of material from relatively distant sources. Proposed protection methods and general order-of-magnitude estimates of costs for each area of critical erosion along the Texas Gulf shoreline are presented in Table 3. Similar information for the bay and estuary shorelines is contained in Table 4.

PHOTOGRAPH 27 - North shore East Bay, Zone B. Photo taken in 1958 showing smooth cordgrass (Spartina Alterniflora) being planted in experimental effort to halt serious erosion. (USDA - Soil Conservation Service Photograph.)



PHOTOGRAPH 28 - Same area as photograph 27 showing cordgrass shore protection 12 years after planting.

TABLE 3

CRITICAL EROSION PROTECTION METHODS AND COSTS
(Gulf Shoreline)

Zones	Areas	Length (miles)	Remedial action	First cost ($1,000)
A		0		
B	1	14.1	Beach nourishment and groins	21,150
	2	1.1	Beach nourishment and groins	1,650
	3	1.9	Beach nourishment and groins	2,850
	4	8.6	Beach nourishment and groins	12,900
C	1	1.3	Beach nourishment and groins	1,950
D	1	5.7	Beach nourishment and groins	8,550
E		0		
F		0		
G		0		
H	1	3.4	Beach nourishment and groins	2,790

TABLE 4

CRITICAL EROSION PROTECTION METHODS AND COSTS
(Bay and Estuary Shoreline)

Zones	Areas	Length (miles)	Remedial action	First cost ($1,000)
A	0			
B	1	7.2	Riprap revetment	2,200
	2	2.0	Riprap revetment	600
		0.5	Beach nourishment	250
	3	1.0	Riprap revetment	300
	4	0.4	Riprap revetment	80
	5	1.2	Riprap revetment	300
	6	9.6	Riprap revetment	2,400
	7	0.4	Seawall	200
C		0		
D		0		
E	1	2.5	Riprap revetment	625
	2	0.5	Riprap revetment	125
	3	2.1	Riprap revetment	525
	4	2.6	Riprap revetment	520
	5	1.8	Riprap revetment	360
	6	0.3	Riprap revetment	90
	7	5.5	Riprap revetment	1,100
		0.5	Beach nourishment	250
	8	0.1	Riprap Revetment	30

Table 4 cont'd

Zones	Areas	Length (miles)	Remedial action	First cost ($1,000)
F	1	0.5	Riprap revetment	100
	2	1.0	Riprap revetment	200
	3	0.6	Riprap revetment	150
G	1	1.3	Riprap revetment	325
	2	1.3	Beach nourishment	1,300
	3	3.5	Riprap revetment	700
	4	1.0	Riprap revetment	200
		0.5	Seawall	250
	5	1.0	Riprap revetment	250
	6	3.0	Riprap revetment	600
		0.8	Seawall	400
	7	2.0	Riprap revetment	400
		0.5	Seawall	250
	8	1.4	Beach nourishment	1,400
H	1	0.8	Riprap revetment	160
	2	0.2	Seawall	60

CONCLUSION

32. The beaches along the Texas coast are a valuable resource and receive extensive use for public recreation and enjoyment. The value of the shore areas will continue to increase with the rapid development of the coastal zone. As the development increases, the erosion problem will become more acute and consequently more difficult and costly to control. For these reasons, the most efficient and economical methods of control should be employed without delay to preserve the beaches and shoreline of this state.

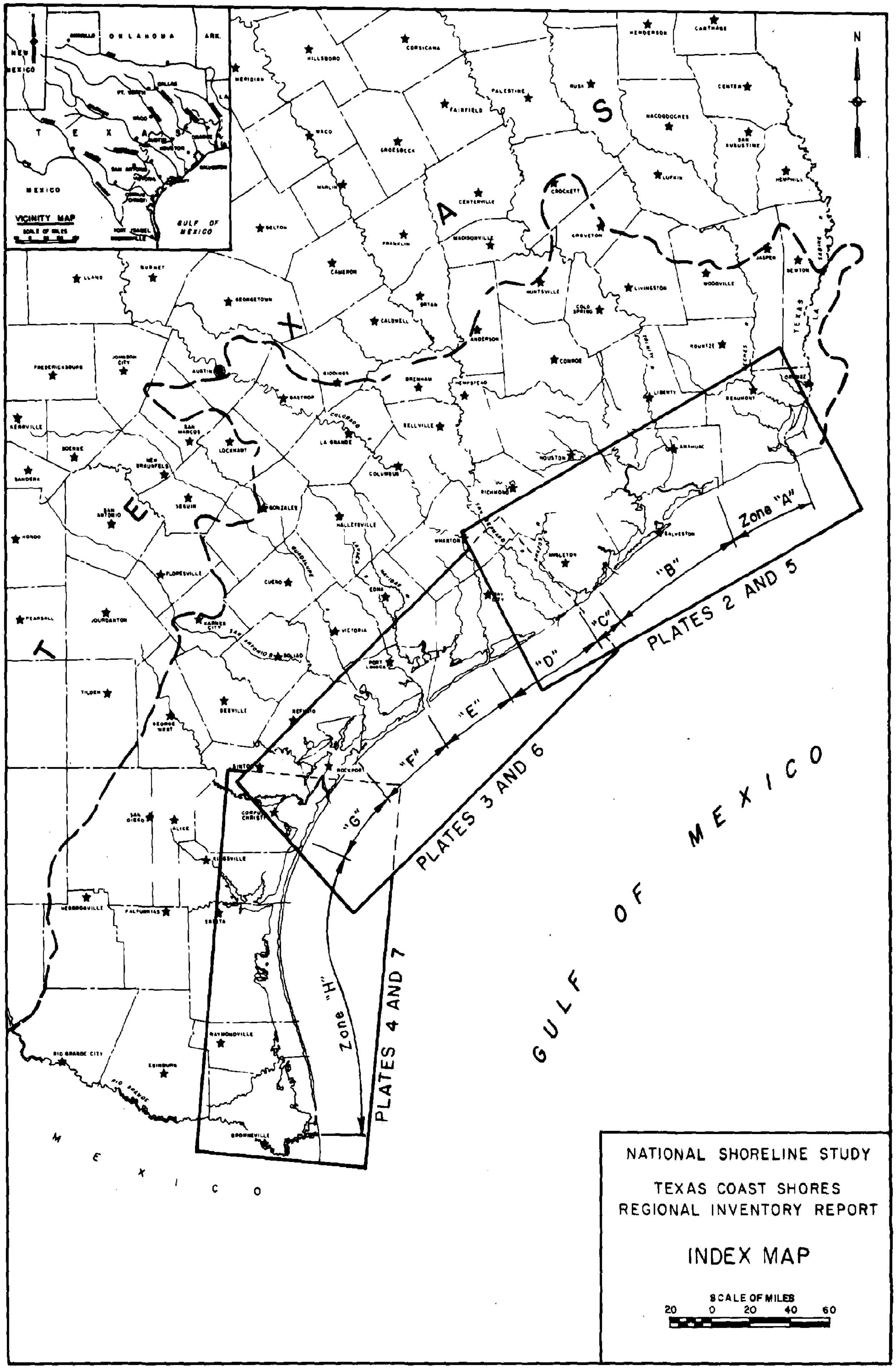

NATIONAL SHORELINE STUDY
TEXAS COAST SHORES
REGIONAL INVENTORY REPORT
INDEX MAP
SCALE OF MILES
20 0 20 40 60
VICINITY MAP
GULF OF MEXICO
MEXICO
TEXAS
PLATES 2 AND 5
PLATES 3 AND 6
PLATES 4 AND 7
Zone "A"
"B"
"C"
"D"
"E"
"F"
"G"
Zone "H"
N

PLATE I

REVIEW OF

REGIONAL INVENTORY REPORT

TEXAS COAST SHORES

APPENDIX A

COMMENTS BY OTHER AGENCIES

REVIEW OF
REGIONAL INVENTORY REPORT
TEXAS COAST SHORES

APPENDIX A

COMMENTS BY OTHER AGENCIES

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REVIEW OF
REGIONAL INVENTORY REPORT
TEXAS COAST SHORES

APPENDIX A

COMMENTS BY OTHER AGENCIES

INTRODUCTION

For interagency coordination, the final draft of the Regional Inventory Report was furnished to the following Federal agencies for review and comments:

1. U. S. Fish and Wildlife Service
2. U. S. Bureau of Reclamation
3. National Park Service
4. U. S. Bureau of Outdoor Recreation
5. U. S. Bureau of Mines
6. U. S. Geological Survey
7. National Ocean Survey
8. U. S. Coast Guard
9. Environmental Protection Agency
10. U. S. Department of Agriculture
11. National Marine Fisheries Service
12. U. S. Bureau of Sport Fisheries and Wildlife
13. National Weather Service
14. U. S. Public Health Service

Copies of the report draft were also furnished to the Division of Planning Coordination, Office of the Governor of Texas, for review by concerned departments and commissions of the state government. The reply received from the Office of the Governor of Texas, and letters received from other Federal agencies are presented in this appendix.

IN REPLY REFER TO: RB

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
POST OFFICE BOX 1306
ALBUQUERQUE, NEW MEXICO 87103

July 9, 1971

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1229
Galveston, Texas 77550

Dear Sir:

By letter dated June 25, 1971, referenced SWGED-PC, Colonel Edwin F. Coffee, Jr., requested our comments on the final draft on the Regional Inventory Report of the Texas Coast for the National Shoreline Study.

We have reviewed this draft report and think that it is factual and well done. Our Bureau has not conducted specific studies pertaining to shoreline erosion along the Texas Coast, but are aware of the problem. In particular, we are aware of the damages to estuarine fish and crustacean nursery areas and to wildlife habitat caused by bulkheading and other mechanical methods of shoreline protection in the bays. In paragraphs 29 and 30 of the report, this matter is discussed quite accurately and a method of shoreline protection by vegetative planting is presented. Because of the ecological advantages of the vegetative planting method of shoreline protection, we favor the use of this method above all others.

Thank you for the opportunity to comment on the draft report.

Sincerely yours,

W. O. Nelson, Jr.
Regional Director

cc:
Field Supervisor, BSFW, Div. of River Basin Studies, Fort Worth, Texas

1871 1971

United States Department of the Interior
BUREAU OF RECLAMATION
REGIONAL OFFICE - REGION 5
[redacted]
HERRING PLAZA, BOX H-4377
AMARILLO, TEXAS 79101

IN REPLY
REFER TO: 5-731

JUL 1 1971

Col. Nolan C. Rhodes
District Engineer
Corps of Engineers
Post Office Box 1229
Galveston, Texas 77550

Your Ref: SWGED-PC

Attention: Lt. Col. Edwin F. Coffee, Jr., Deputy District Engineer

Dear Colonel Rhodes:

Please refer to your letter of June 25 furnishing for our review the final draft of your Regional Inventory Report of the Texas Coast for the National Shoreline Study. We have no comments to offer.

Sincerely,

Charles H. Clark

ACTING FOR Leon W. Hill
Regional Director

United States Department of the Interior

NATIONAL PARK SERVICE
Southwest Region
P. O. Box 728
Santa Fe, New Mexico 87501

IN REPLY REFER TO:

L7423

JUL 12 1971

Lieutenant Colonel Edwin F. Coffee, Jr.
Deputy District Engineer
Galveston District, Corps of Engineers
P. O. Box 1229
Galveston, Texas 77550

Dear Colonel Coffee:

We have reviewed your final draft of the Regional Inventory Report of the Texas coast for the National Shoreline Study prepared under authority of Section 106 of the River and Harbor Act of 1968, and have no comment to offer.

The report seems to be complete in its inventory and appraisal of erosion problems.

We are most interested in any future recommendations and specific improvement projects which may concern Padre Island National Seashore and surrounding areas.

Please keep us informed of any future studies or reports concerning these areas.

Thank you for this review opportunity.

Sincerely yours,

Theodore R. Thompson

Acting Director, Southwest Region

United States Department of the Interior
BUREAU OF OUTDOOR RECREATION
MID-CONTINENT REGION
BUILDING 41, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

IN REPLY REFER TO:
D6427-TG
National Shoreline Study

JUL 9 1971

Lt. Col. Edwin F. Coffee, Jr.
Deputy District Engineer
Galveston District, Corps of Engineers
P. O. Box 1229
Galveston, Texas 77550

Dear Colonel Coffee:

We have reviewed the Regional Inventory of the Texas Coast for the National Shoreline Study as requested in your letter of 25 June 1971.

The report seems to satisfactorily describe the areas along the coast where significant erosion occurs and to recommend priorities among the serious problem areas for action to stop erosion.

One thought that comes to mind after looking at the large cost estimates for protection, particularly along the Gulf Shoreline, is, will the public have reasonable access to these publicly rebuilt beaches? We realize there is an Open Beach Act in Texas which apparently allows the public to use the area between low and high water. However, if the property back from the beaches is all privately owned, the public could be effectively excluded.

Perhaps the possibility of providing meaningful public access to some of these rebuilt areas, through easement acquisitions and other means, should be explored.

Under "Improvement Methods" we are glad to see that essentially natural methods such as building up the sand dunes and periodic nourishment of eroded beaches with available sand will be used. However, it is important that the sand not be dredged from bays behind the beach so as to disturb their ecology.

We are also glad to see that the recognition that groins can cause severe erosion problems on the downdraft side if improperly situated. Also, it is recognized that in valuable estuarine areas, structural methods may be more detrimental than the erosion.

Thank you for the opportunity to comment.

Sincerely yours,

John E Rayburn
for Maurice D. Arnold
Regional Director

cc: BOR, WASO, WRP Division A-5
w/copy of incoming letter

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
Intermountain Field Operation Center

Office of
Chief

BUILDING 20
DENVER FEDERAL CENTER
DENVER, COLORADO 80225

June 30, 1971

Your reference:
SWGED-PC

Lt. Col. Edwin F. Coffee, Jr.
Deputy District Engineer
Department of the Army
Galveston District, Corps of Engineers
P. O. Box 1229
Galveston, Texas 77550

Dear Colonel Coffee:

In response to your request of June 25, we have reviewed the final draft of the Regional Inventory Report of the Texas Coast Shores.

The report indicates both the areas of critical erosion (Plates 2 to 4) and the general locations of the principal oil and gas fields, which do not coincide. Therefore, it is improbable that the potential improvements would affect the extraction and transportation of oil and gas either beneficially or adversely. This office thus has no objections to the report as written.

Further information about minerals in the general area, together with our reviews on environmental impact statements relating to specific projects, may be found in our letters to D. T. Graham of your office, dated December 15, 1970 (partly on Corpus Christi Ship Channel), January 26, 1971 (Highland Bayou in Galveston area), February 4, 1971 (Port Isabel Side Channels and Port Aransas Breakwater), February 22, 1971 (Cedar Bayou, Clear Creek, Chocolate Bayou, Gulf Intracoastal Waterway-Mouth of Colorado River, and Taylors Bayou), and June 11, 1971 (relocation of Gulf Intracoastal Waterway at Port Isabel).

Sincerely yours,

O. M. Bishop

O. M. Bishop, Chief
Intermountain Field Operation Center

United States Department of the Interior

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION
FEDERAL BUILDING
300 EAST 8TH STREET
AUSTIN, TEXAS 78701

June 30, 1971

SWGED-PC

Col. Edwin F. Coffee, Jr.
Deputy District Engineer
Corps of Engineers
Galveston District
P. O. Box 1229
Galveston, Texas 77550

Dear Col. Coffee:

This is in reply to your letter of June 25, 1971 concerning the draft of the Regional Inventory Report of the Texas coast.

The Water Resources Division office is not directly involved in coastal erosion; therefore, we feel that our review of this report would be inappropriate. The report is of some interest to us, and I have taken the liberty of retaining the three draft copies.

I am sorry we are unable to provide the review that you requested.

Sincerely yours

A. G. Winslow
Acting District Chief

AGW:lk

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Survey
601 E. 12th Street, Room 1436
Kansas City, Missouri 64106

July 2, 1971

Lt. Col. Edwin F. Coffee, Jr.
Deputy District Engineer
Department of the Army
Galveston District, Corps of Engineers
P. O. Box 1229
Galveston, Texas 77550

Dear Colonel Coffee:

Thank you for the opportunity to review the final draft of the Regional Inventory Report of the Texas coast for the National Shoreline Study.

This organization has placed many survey monuments along this coast. The rate of erosion of the shoreline affects the duration of useful life of these monuments. We attempt to perpetuate the marks by relocating them as necessary to escape the effects of shore erosion, but lack personnel and funds to make our attempts fully effective. We, of course, heartily endorse all programs of shoreline protection which tend to preserve our stations.

We also request that contracts you let for construction of shore protection take cognizance of survey stations set by this organization and known by your survey personnel. Since construction personnel destroy many stations either through lack of knowledge of their value and purpose or through lack of knowledge of the means by which they are preserved, we request that construction specifications specifically provide for advising this office of the necessity of relocating any stations which may fall within the construction area. This notification should allow us 60 to 90 days to schedule the required preservation operation.

Sincerely,

G L Short

G. L. Short
CAPT, NOAA
Mid-Continent Field Director
National Ocean Survey

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDER (oan)
Eighth Coast Guard District
Customhouse
New Orleans, La. 70130

5701/ERI-GALV
Ser [illegible]9
1 JUL 1971

From: Commander, Eighth Coast Guard District
To: District Engineer, U.S. Army Corps of Engineers District, Galveston

Subj: Texas Regional Inventory Report, National Shoreline Study

Ref: (a) CofE Galv ltr SWGED-PC of 25 June 1971

1. As requested in reference (a), your Texas Regional Inventory Report, National Shoreline Study, has been reviewed.

2. The conceptual plans for shoreline protection indicate little, if any effect on navigation, our primary concern, and no specific comments are developable at this general stage of your planning.

3. Review of Detailed Project Reports for specific protection plans, when developed, is of course desired.

J. E. DAY
Captain, U. S. Coast Guard
Chief, Operations Division
By direction of Commander
Eighth Coast Guard District

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAMS
DIVISION OF PLANNING & INTERAGENCY PROGRAMS
1402 Elm Street, Third Floor
Dallas, Texas 75202

July 12, 1971

Lieutenant Colonel Edwin F. Coffee, Jr.
Deputy District Engineer
U. S. Army Engineer District, Galveston
P. O. Box 1229
Galveston, Texas 77550

Dear Colonel Coffee:

Your final draft of the Regional Inventory Report of the Texas coast for the National Shoreline Study has been reviewed as requested in your June 25, 1971 letter.

We concur in your recommendation for protection and restoration programs. However, we suggest that your comment "in areas of valuable estuarine habitat, structural measures may be more detrimental than the actual erosion" be further discussed to fully apprise Congress of the extent of erosion existing and anticipated in areas of valuable estuarine habitat.

Sincerely,

Mac A. Weaver

MAC A. WEAVER, Acting Chief
General Planning & Assistance Activities

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. Box 648
Temple, Texas 76501

July 7, 1971

Lt. Colonel Edwin F. Coffee, Jr.
Deputy District Engineer
Galveston District, Corps of Engineers
Department of the Army
P. O. Box 1229
Galveston, Texas 77550

Dear Colonel Coffee:

This is in reference to your final draft of the Regional Inventory Report of the Texas coast for the National Shoreline Study. We have reviewed your report and feel consideration has been given to all aspects of the problems involved in shoreline erosion. Treatment methods have included the known possibilities for limited vegetative control. It is known that all along the coast, wind erosion carries the soil particles of saline content inland that result in severe damage to vegetation as well as utilities and other properties.

Inasmuch as the Soil Conservation Service provided available data and information in regard to the shoreline erosion problems, we do not have additional information or comment for change or improving the report. We feel that it presents the problems and the known possibilities for treatment.

Sincerely,

for Clyde W. Graham
State Conservationist

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Regional Office, Region 2
Federal Building
144 First Avenue South
St. Petersburg, Florida 33701

July 12, 1971

Mr. D. T. Graham
Chief, Engineering Division
U.S. Army Corps of Engineers
Post Office Box 1229
Galveston, Texas 77550

Dear Mr. Graham:

We have reviewed the final draft of the Regional Inventory Report of the Texas Coast as requested by your letter dated June 29, 1971.

We have but one recommendation, namely, that the vegetative planting method (#30. page 22) be used whenever possible in preference to bulkheading for the protection of shorelines.

Sincerely yours,

R. T. WHITELEATHER
Regional Director

EXECUTIVE DEPARTMENT
AUSTIN, TEXAS 78711

PRESTON SMITH
GOVERNOR

July 30, 1971

Lt. Col. Edwin F. Coffee, Jr.
Deputy District Engineer
Galveston District, Corps
of Engineers
P. O. Box 1229
Galveston, Texas 77550

Dear Colonel Coffee:

The Office of the Governor, Division of Planning Coordination (the State Planning and Development Clearinghouse), and the affected Texas State agencies have reviewed the National Shoreline Study, Texas Coast Shores, Regional Inventory Report of the U. S. Corps of Engineers.

The study is a comprehensive report on the effects of coastal erosion along Texas and is excellent in its detail and analysis.

Enclosed are the comments received from the responding State agencies on the shoreline inventory.

Thank you for the opportunity to review this document.

Sincerely,

Ed Graham for

Dan S. Petty
Director, Division of
Planning Coordination

DSP:aps

Enclosures (4)

cc: Mr. Harry Burleigh
Executive Director
Texas Water Development Board

TEXAS
PARKS AND WILDLIFE DEPARTMENT

JAMES U. CROSS
EXECUTIVE DIRECTOR

JOHN H. REAGAN BUILDING
AUSTIN, TEXAS 78701

July 13, 1971

Mr. Dan S. Petty, Director
Division of Planning Coordination
Office of the Governor
Sam Houston State Office Building
Austin, Texas 78701

Dear Mr. Petty:

We have reviewed and concur with the final draft of the National Shoreline Study, Texas Coast Shores, Regional Inventory Report prepared by the U. S. Corps of Engineers, Galveston, Texas.

We appreciate having had the opportunity to review this draft report and find it to be well presented.

Sincerely,

James U. Cross
Executive Director

AGENCY RESPONSE FORM

Please Return under SEPARATE COVER to:

Governor's Office
Division of Planning Coordination

Date July 6, 1971

Reviewing Agency:

Name Texas State Soil & Water Conservation Board

Address 1018 First National Building, Temple, Texas 76501

Grant Applicant or Author of Document:

Name U. S. Corps of Engineers

Address

Document Number

Project Description:

Regional Inventory Report of the Texas Coast for the National Shoreline Study of the U. S. Corps of Engineers.

Certification:

The plan, proposal or project described is /xx/ is not /__/ consistent with the plans and policies of this agency, and of the State of Texas, as it relates to the area of jurisdiction in which it is located.

Comments and Recommendations:

Harvey Davis
(Signature)
Authorized representative of reviewing agency

TEXAS HIGHWAY DEPARTMENT

AUSTIN, TEXAS 78701

July 1, 1971

IN REPLY REFER TO
FILE NO. D-5

Regional Inventory Report of the Texas Coast
for the National Shoreline Study of the U.S.
Corps of Engineers

Mr. Dan S. Petty, Director
Div. of Planning Coordination
Office of the Governor
P. O. Box 12428, Capitol Station
Austin, Texas 78711

Dear Dan:

We have reviewed the draft of the above report which accompanied your memorandum dated June 28, 1971 and do not take exception to the statements made.

Sincerely yours

J. C. Dingwall
State Highway Engineer

By: Marcus L. Yancey Jr.

Marcus L. Yancey, Jr.
Administrative Engineer

TEXAS WATER DEVELOPMENT BOARD

HARRY P. BURLEIGH
EXECUTIVE DIRECTOR

P.O. BOX 13087
CAPITOL STATION
AUSTIN, TEXAS 78711

AREA CODE 512
475-2201

301 WEST 2ND STREET

JUL 7 1971

IN REPLY REFER TO:
TWDBP

RECEIVED
JUL 7 1971
Div. of Plan. Coord.

Mr. Dan S. Petty, Director
Division of Planning Coordination
Office of the Governor
P. O. Box P, Capitol Station
Austin, Texas 78711

Dear Mr. Petty:

We are pleased to comply with your request of June 28, 1971 for comments on the Regional Inventory Report of the Texas Coast for the National Shoreline Study, which was prepared by the U. S. Army Corps of Engineers. We have carefully reviewed the final draft of this investigation, particularly in regard to natural and man-made influences on the hydrodynamics and ecology of the bay and estuarine areas.

We found the report to be comprehensive and to provide an excellent inventory of current activities on the Texas Coast and the effects of erosion and littoral transport in these areas. The consideration given in the report to the preservation of the estuarine ecology in the conception and design of erosion control measures is of great importance. We feel that the use of native vegetation for erosion control, where feasible, is probably the best, most economical, and most environmentally sound solution to this problem. The information provided in this inventory should prove to be very useful to all agencies involved in the management of Texas coastal and estuarine areas.

We appreciate the opportunity to offer comments on the

draft of the inventory and look forward to receiving the other reports in this series.

Sincerely,

Harry P. Burleigh